



Author Index

	PAGE		PAGE
A. A. K. (Rev.)	118	Bhatnagar, G. C.	110
Achan, P. D.	265	Bhatnagar, M. P.	271, 477
Agarwala, S. C.	427	Bhatnagar, P. L. (Rev.)	117, 314
Agarwala, V. S.	12	Bhatnagar, S. S.	420
Aghoramurthy, K.	213	Bhat, N. R.	425
Agnihotri, J. P.	65	Bhattacharjee, P. N.	103, 181
Agnihothrudu, V.	24	Bhattacharya, A. K.	380
Ahuja, L. R.	473	Bhattacharya, Arun K.	14
A. J. (Rev.)	34, 355	Bhatt, M. V. (Rev.)	438
Anantharaman, T. R.	379	Bhatt, V. P.	293
Ansari, M. N. A.	193	Bhavsar, C. M.	51
Anselm Austin	24	Bheemasankara Rao, Ch.	259, 333, 414
A. R. V. (Rev.)	73	Bilgrami, K. S.	343, 348
A. S. G. (Rev.)	119, 157, 159, 275, 315, 355, 396, 439, 480, 483	Bose, S. R.	307
Atal, C. K.	177, 338	Brahm Dev	457
Atwal, A. S.	435	Broadbridge, E. S.	290
Aziz Khan, A.	141	B. R. S.	364
		B. S. T. (Rev.)	35, 241
BABU, C. N.	113		
Babu, D. R. C.	417	CAPOOR, S. P.	353
Babu Rao, P.	332	Cecily (Miss) P. J.	319
Babu, S. K.	19, 384	Chacko, M. J.	69, 73
Badkas, D. J. (Rev.)	356	Chakravarty, R.	423
Balakrishnan, V.	16	Chakravarty, S. C.	224
Balakrishna, S.	183, 264, 410	Chakravartti, M. R.	463
Balaram Sahoo	293, 380	Chandrasekhariah, M. S.	336
Balasubramanian, M.	149	Chandrasekhariah, S. R.	392, 476
Banerjee, D. K. (Rev.)	120, 356	Chandratreya, P. V.	137
Banerjee, S. P.	380	Channa Basavanna, G. P.	111, 114
Basu, A. N.	390	Chatterji, A. K.	75
Baxi, A. J.	16	Chatterji, S.	104, 105, 230, 391
Baxi, K. K.	267	Chaturvedi, S. K.	112
Bedi, S. J.	191, 403	Chauhan, L. S.	273
Bhagiratha Rao, E.	9	Chavan, A. R.	191, 403
Bhandari, M. M.	154	Chiplonkar, V. T.	98
Bharati Mehra	308	Chiranjivi Rao, K.	113
Bharucha, F. R.	67	Chopra, I. C.	223
Bhaskar Rao, H. V.	221	Chopra, S. L.	203
Bhatia, D. S.	381	Choughuley, A. S. U.	99
Bhatia, S. K.	327	Cseh, E.	102
Bhat, J. V.	382	DABHOLKAR, M. V.	39
Bhatnagar, C. S.	11	Das, B. C.	203
Bhatnagar, G.	304		

		PAGE		PAGE
Dasgupta, J.	.. ..	150	HABBU, M. K.	.. ..
Das Gupta, S. N.	.. ..	450	Haldane, J. B. S.	.. ..
Das, M. R.	.. ..	370	Haldane, J. B. S. (<i>Rev.</i>)	.. ..
Das, S. R.	.. ..	138	Handoo, O. N.	.. ..
Das, U. K.	.. ..	380	Hanumantha Rao, K.	.. ..
Datar, M. G.	.. ..	455, 456	Hardas, M. W.	.. ..
Datta, S. N.	.. ..	182	Herwald, S. W.	.. ..
Daya Bhanu	.. ..	420	H. S. R. (<i>Rev.</i>)	.. ..
Dekate, Y. G.	.. ..	263		
Deoras, P. J.	.. ..	465	IAN FELLS	.. ..
Deshpande (Miss) U. P.	.. ..	21	I. H. (<i>Rev.</i>)	.. ..
Deshpande, V. T.	.. ..	377	Islam, A. S.	.. ..
Desikachar, H. S. R.	.. ..	261, 337	Iswaran, V.	.. ..
Dhanda, M. R.	.. ..	228	Iyer, R. D.	.. ..
Dhande, G. W.	.. ..	351	Iyer, V.	.. ..
Dharampal Singh	.. ..	27, 62	Iyengar, N. K. (<i>Rev.</i>)	.. ..
Dhareshwar, B. V.	.. ..	336	Iyengar, R. L. N. (<i>Rev.</i>)	.. ..
Dhatt, M. S.	.. ..	179		
Dhawan, C. L.	.. ..	107	JACOB, S. C.	.. ..
Dhawan, N. L.	.. ..	109, 233	Jadhav (Miss), Kamai A.	.. ..
Dias, F. F.	.. ..	382	Jagathesan, D.	.. ..
Dmitruk, A. P.	.. ..	448	Jain, B. D.	.. ..
Dutta, S. N.	.. ..	53	Jain, J. S.	.. ..
Dutt, S.	.. ..	104	Jain, S. K.	.. ..
Dwivedi, J. N.	.. ..	342	Jain, S. P.	.. ..
EDITH CSEH	.. ..	102	Jai Prakash Narain, R. K.	.. ..
Eswaran, K. S. S.	.. ..	352	Jambor, B.	.. ..
Ethirajan, A. S.	.. ..	350	Janardana Sarma, T.	.. ..
FERNANDES, F.	.. ..	420	Jijie, K.	.. ..
GANAPATI, P. N.	.. ..	61, 225, 464	Joginder Singh	.. ..
Ganapathy, P. S.	.. ..	190	Johnson, P. V.	.. ..
Gandhi, S. M.	.. ..	271	Jones, F. G. W.	.. ..
Ganesan, A. S.	.. ..	285	Joshee, A. K.	.. ..
Ganguly, P.	.. ..	300	Joshi, A. B.	.. ..
Gangwar, B. M.	.. ..	319	Joshi, P. V.	.. ..
Garga, R. P.	.. ..	345	Jugal Kishore	.. ..
Gautam, O. P.	.. ..	473	J. V. B. (<i>Rev.</i>)	.. ..
George, M. G.	.. ..	268	KACHHAWAHA, M. S.	.. ..
Ghosh, R. B.	.. ..	73	Kadkol, S. B.	.. ..
Ghosh, R. N.	.. ..	69	Kailasam, L. N.	.. ..
Gonzalves, Ella A.	.. ..	143	Kalani (Miss), I. K.	.. ..
Gopala Aiyar, K. V.	.. ..	113	Kalke, J. R.	.. ..
Gopalakrishnan, K.	.. ..	257	Kamal Mohnot	.. ..
Gopal Swarup	.. ..	360	Kamat, D. N.	.. ..
Govekar, G. M.	.. ..	263	Kamat, V. N.	.. ..
Govil, G.	.. ..	252, 331	Kameswara Rao, B. V.	.. ..
Govindan Nayar, K. N.	.. ..	228	Kameswara Rao, K.	.. ..
Goyal, S. K.	.. ..	154	Kandasami, P. A.	.. ..
Grigoryan, A. T.	.. ..	247	Kanekar, C. R.	.. ..
Guglani, P. L.	.. ..	109	Kanwar, J. S.	.. ..
Guha, S. R. D.	.. ..	143	Kapoor, B. M.	.. ..
Gupta, P. K.	.. ..	10	Kapoor, J. N.	.. ..
			Kapur, O. P.	.. ..
			Kapur, S. L. (<i>Rev.</i>)	.. ..

	PAGE		PAGE
Karamchandani, S. J.	373	Marimuthamal, S.	22
Karezmarz, K.	313	Mathur, A. C.	223
Karibasappa, B. K.	432	Mathur, B. N.	477
Kartha, K. N.	221	Mathur, P. N.	354
Kashikar, M. D.	142	Mathur, R. L.	65
Kashyap, R. L.	366	Mathur, R. S.	203, 272, 307, 312, 360
Katiyar, S. S.	175	Mathur, S. L.	471
Kaul, K. N.	131	Mecke, R.	43
Kaur, S.	298	Mehdiratta, R. C.	147
Kessar, S. V.	414	Mehra, B.	308
Khanolkar, D. D.	52	Mehta, C. M.	15
Khanolkar, V. R. (Rev.)	238, 276, 431	Mehta, C. R.	460
Khanwilkar, V. G.	31	Merchant, J. R.	99
Khetrapal, C. L.	252, 331	Merchant, R. N.	455
Khoshoo, T. N.	327	Mhatre, H. K.	263
Kishan Singh	63	Mirashi, M. V.	430
Kishen, K.	407	Mir Hamid Ali	486
Knypl, J. S.	264, 448	Misra, A. P.	189
Kohli, R. C.	340	Misra, J. S.	262
Krishnamurti, B. G.	383	Misra, M. P.	272, 307, 360
Krishnamurty, K. G.	287	Misra, R. C.	163
Krishnamurty, K. V.	467	Misra, R. N.	70
Krishnan, A. A. (Rev.)	397	Misra, U. S.	31
Krishnan, R.	306, 435	Mitra, G. C.	131
Krishnaswami, S.	152, 353	Mitra, G. N.	395
K. R. (Rev.)	81, 121, 201, 280, 441	M. K. S. (Rev.)	242
K. S. V. (Rev.)	157, 275, 314, 437, 479	Mohnot, K.	427
Kukla, A. S.	218	Mookherji, A.	217
Kulkarni, A. B.	101, 142	M. R. A. (Rev.)	34, 78
Kuriyan, G. K.	319	M. R. S. (Rev.)	201, 280
Kushwaha, K. S.	229, 266	M. S. K. (Rev.)	440
K. V. (Rev.)	275, 438	Mukherjee, D. P.	138, 433
LAKSHMANA RAO, M. V.	464	Mukerji, K. G.	231, 345
Lakshmi Bai, C.	134, 366	Mukundan, M. A.	461
Lakshminarayanaiah, N.	13, 258	Munjal, R. L.	308
— (Rev.)	397	Munshi, A. A.	219
Lal, S. B.	273	Murty, B. R.	467
Leelanandam, Ch.	20, 115	Murty, G. S.	467
Lekshmy, A.	383	Murty, M. S.	295
Lewis, E. J.	143	NAGARAJAN, G.	377, 413
Lewis, Y. S.	381	Naha, P. M.	417, 462
Lingaraj, D. S.	392	Nair, N. R.	474
MADAN, T. N. (Rev.)	37, 82	Narasimhan, K. C.	139
Madhavi, R.	303	Narasimha Murthy, D. P. (Rev.)	481
Magoon, M. L.	347	Narayanan, S.	340
Mahajan, K. P.	414	Natarajan, B. V.	145
Malhotra, C. L.	296	Nayak, V. N.	188
Malik, Wahid U.	141	Nayar, K. K.	223
Maneck, S. S.	98	Nedungadi, T. M. B.	363
Mankad, B. N.	335	Neelakantan, S.	416
Manohar, H.	5	Neogy, D.	90, 381
		Nirula, K. K.	217
		Norrish, R. G. W.	319
			405

	PAGE		PAGE
PANDHYE, A. A.	180	Raheja, P. C. (<i>Rev.</i>)	279
Padmanabhan, D.	424	Rai, J. N.	231, 345
Paharia, K. D.	354	Raizada, M. B. (<i>Rev.</i>)	400
Pai, R. M.	274	Rajagopalan, K.	145, 257
Pal, A.	300	Rajagopalan, N.	222
Paliwal, G. S.	269	Rajagopalan, S. R.	459
Pande, P. G.	59, 147, 267, 299	Raja Rao, B.	226
Pandey, I. C.	312	Raja Rao, T.	211
Pandya, N. S.	293	Raju, T. S.	329
Panje, R. R.	211	Ramachandra Iyer, P. K.	147, 299
Pant, D. D.	308	Ramachandran, G. N.	127
Pant, P. C.	143	Ramachandran, K.	194
Paradkar, S. A.	430	Ramachandra Rao, B.	9
Parameswaran, N.	344	Ramachandra Rao, S.	188
Parameswaran, S.	39	Ramaiah, A.	219
Parameswar, N. S.	476	Ramaiah, N. A.	175
Parthasarathy, M. R.	333	Ramakrishnan, Alladi (<i>Rev.</i>)	33
Patel, B. D.	393	Ramakrishnan, K.	431
Patel, G. H.	15	Ramakrishnan, S.	416
Patel, K. A.	234	Ramana Rao, B. V.	305
Patel, K. S.	335	Ramana Rao, D. V.	259
Patel, N. J.	51	Ramanna, M. S.	347
Pathak, G. N.	434	Rama Rao, P.	379
Pathki, K. G.	379	Ramaseshan, S.	5
Patil, B. V.	155	Ramaswami Ayyar, P. (<i>Rev.</i>)	316
Patnaik, D.	54, 293, 380	Ramaswamy, M. S.	17
Perur, N. G.	58	Rampal, A. L.	414
Phatak, D. M.	101	Ram Udar	22
Pillai, C. K. C. S.	430	Randhawa, H. S.	224
Pillai, V. K.	388	Ranganathan, S. R. (<i>Rev.</i>)	201, 442
Plyler, Earle K.	1	Ranga Rao, D. R.	232
Prasad, A. B.	30	Rangaswami, G.	25, 64, 149, 352
Prasad, A. R.	193	Rao, A. N.	426
Prasad, M. R. N. (<i>Rev.</i>)	317	Rao, C. N. R. (<i>Rev.</i>)	199, 356
Prasad, N.	65, 110	Rao, J. T.	349
Prakash, P.	228	Rao, L. N.	388
Prakash, Sarup	230	Rao, P. N.	433
Priti Awasthi (Miss)	469	Rao, R. S.	244
Pujari, S. K.	380	Rao, V. S. R.	453
Purkayastha, B. K.	152	Reddy, D. B.	192
Puri, V. (<i>Rev.</i>)	442	Renga Ayyar, G.	29
Purna Chandra	325	Richharia, R. H.	30, 189
Purohit, M. L.	31	Rishi, A. K.	182, 261
Pushkarnath (<i>Rev.</i>)	399	Rolla, S. R.	310
Puttarudriah, M.	114	Roy, B. B.	106
— (<i>Rev.</i>)	358	Roy, J. K.	30
QARYUM, F.	433	Roy, R. P.	26
RACHIE, K. O.	107	SABNIS, S. D.	191, 403
Racine, C. (<i>Rev.</i>)	117, 198, 437, 479	Sadasivan, T. S.	45
Radhakrishnamurty, R.	261	— (<i>Rev.</i>)	278
Raghavan, R. S.	310	Sahadevan, P. C.	325, 474
Raghavarao, K. V.	329	Saksena, S. D.	31
Raghava Rao, M.	264	Sandhu (Mrs.), D. K.	224
Rahalkar, G. W.	105, 391	Sandhu, R. S.	224

	PAGE		PAGE
Sanghvi, L. D.	16	Sreedhara Murthy, N.	216
Saraswathy Royan	148	Sreerama Murty, K.	332
Sarma, P. S. (<i>Rev.</i>)	35, 238, 277, 316,	Sreeramulu, C.	188
Sasisekharan, V.	357	Sreenivasaya, M.	417
Sastry, A. S.	127	Srimathi, R. A.	417
Sathyanesan, A. G.	108	Srinivasagam, R. T.	196
Satish Chandra	302	Srinivasan, K. V.	425
Satyanareshwar Rao, V. R.	22	Srinivasan, V.	416
Saxena, G. P.	176	Srinivasan, V. V.	185, 353
Saxena, H. B.	140	Srivastava, J. B.	223
Saxena, P. N.	56	Subba Rao, B. C.	218
Saxena, R. S.	105, 391	Subba Rao, B. R.	69
Sekariah, P. C.	140	Subba Rao, K. S.	188
Sen, A. C.	59, 147, 228, 267,	Subba Rao, M. N. (<i>Rev.</i>)	160, 439
Sen Gupta, S. K.	299	Subbiah, B. V.	180
Sen, N. K.	307	Subramanyam, S. V.	454
Seshadri, T. R.	306, 435	Subrahmanyam, R.	289
Seshu, D. V.	90, 218, 287,	— (<i>Rev.</i>)	36, 240, 440
Sethi, G. R.	333	Subrahmanyam, V.	13, 261
Sethi, J. K.	105, 391	Subramaniam, M. K.	172
Shah, G. Z.	177, 338	— (<i>Rev.</i>)	120, 161, 202
Shah, N. B.	215	Subramanyam, S.	172
Shah, P. R.	460	Subramaniam, C. P.	431
Shah, S. M.	415	Subramanian, C. V.	423
Shambulingappa, K. G.	155	— (<i>Rev.</i>)	79, 481
Shankar, J. V.	347	Sulaiman, M.	351
Shanmugasundaram, E. R. B.	67	Sulbha, K.	67
Shanthakumari, K.	219, 461	Sundararajan, S.	139
Sharma, A. K.	225	Sundaram, T. K.	461
Sharma, C. P.	75	Sur, B. K.	56, 297, 462
Sharma, C. P.	427	Suryanarayana, D.	114
Sharma, J. C.	266	S. V. C. (<i>Rev.</i>)	159, 480
Sharma, L. S.	266	Swaminathan, K.	319, 418
Shastry, S. V. S.	70, 232	Swaminathan, M. (<i>Rev.</i>)	120, 241
Shekhawat, G. S.	477	Swaminathan, M. S.	67, 155
Shivaramiah, G.	190	Swamy, B. G. L.	424
Shrivastava, B. P.	262		
Shukla, R. R.	59, 147, 267,	TALUKDAR, J. N.	28, 274
Siddiqui, Z. A.	299	Tandan, P. C.	162
Singh, D.	193	Tandon, R. N.	343, 348
Singh, K.	12, 137	Tandon, S. L.	72, 476
Singh, K. P.	54	Tawde, N. R.	137, 216
Singh, P. P.	434	Tewari, B. S.	360
Singh, P. P.	297, 462	Tewari, J. P.	231
Singh, S. N.	62	Teaotia, S. S.	312
Singh, S. I.	297	Thaker, B. M.	215
Singh, T. P.	302	Thapliyal, J. P.	304
Singh, V. P.	63	Thirumalachar, M. J.	180
Sinha, R. P.	63	Tontadarya, T. S.	111
Sinha, U.	26	Tiagi, B.	427
Sircar, S. M.	30	Tilak, B. V. K. S. R. A.	459
Sirsi, M. (<i>Rev.</i>)	428	Tonapi, G. T.	226
Sitaramachandramurthy, A.	37, 79, 122, 241,	Tripathi, B. K.	131
Sneh Lata Mathur	279, 317	Trivedi, B. S.	112
Solomon Raju, N.	336	Trivedi, J. P.	219, 294, 415
Sonalkar, V. G.	471		
S. P. (<i>Rev.</i>)	61		
	456		
	158, 197, 198,		
	236		

SUBJECT INDEX

[Vol.

XXX

	PAGE	PAGE
Trivedi, K. N.	54	Venkatraman, T. V.
Tyagi, B. N.	407	73, 107, 435
UDAI BHAN SINGH	477	10
Udupa, H. V. K.	139	203
U. G. (Rev.)	80	436
V		349
VAIDYANADHAN, R.	221, 386	293
Vaidya, P. B.	187	353
Varadaiah, V. V.	453	258
Varma (Miss), Asha	137	359
VasanthaRajan, V. N.	26, 149	343
Vasanth Gurunath Rao	470	353
Vasudeva Murthy, A. R.	176	236
Venkataraman, B.	7	376
Venkataramani, K. S.	186, 319	217
Venkata Ram, C. S.	57, 186	YEDDANAPALLI, L. M. (Rev.) ..
Venkatesan, R.	64	..
Venkateswarlu, V.	259, 333, 414	ZAKA-UR-RAB, MD. ..

Subject Index

	PAGE	PAGE
ABNORMAL Conjugation in <i>Spirogyra braziliensis</i>	154	Aerosol Layer in the Stratosphere ..
ABO Blood Groups in the Raj Gonds ..	181	Aerosols—Science and Technology (Rev.) ..
Absorption Cross-Sections for Nuclear Scattering of High Energy Nucleons ..	215	Algae, Cultivation of, in Heavy Water
Acetic Fermentation of Molasses ..	383	All-Glass Sprayer for Paper Chromatography ..
Acoustic Radiation by Insects ..	164	Alpha Activities of Drinking Waters of Britain ..
Aerasiales, Occurrence of, in Indian Soils ..	24	<i>Alternaria</i> , A New Species from Bombay ..
Acyl Isothiocyanates: Friedelcraft Reaction ..	294	—, Studies in the Enzyme Make-up of Amino-Acid Deficiency of the Proteins of Lucerne Leaf ..
Addison-Wesley Series in Physics—Reading (Massachusetts, U.S.A.) (Rev.) ..	199	— — Make-up of <i>Santalum album</i> ..
Advances in Agronomy, Vol. XII (Rev.) ..	279	Amitosis in the Endosperm of <i>Zephyranthes ajax</i> ..
— in Analytical Chemistry and Instrumentation (Rev.) ..	356	Amperometric Determination of Cerium (IV) and Fe (III) ..
— in Catalysis and Related Subjects, Vol. XII (Rev.) ..	480	Analytical Elements of Mechanics, Vols. I and II (Rev.) ..
— in Chemical Physics, Vol. II (Rev.) ..	157	157, 433
— — —, Vol. III (Rev.) ..	396	Anchovy <i>Thrissocles vitirostris</i> from Indian Waters ..
— in Morphogenesis, Vol. I (Rev.) ..	442	Anion Uptake of a Cation Exchange Resin ..
— in Documentation and Library Science, Vol. III, Parts I and II (Rev.) ..	201, 442	258
— in Organic Chemistry (Rev.) ..	120	Annual Reports of the Progress of Chemistry for 1959 (Rev.) ..
— in Space Science, Vol. II (Rev.) ..	437	439
<i>Aeginetia indica</i> , Linn. Hosts of the Root Parasite ..	319	Antennæ of <i>Gerris fluviorum</i> , on the Growth of ..
— — —, Observations on a Root Parasite ..	191	Anthropology, Biennial Review of (Rev.) ..

	PAGE		PAGE
Apetalous Mutation in <i>Tora Brown Sarson</i> and its Inheritance ..	62	Breakdown of the Papilionaceous Structure in <i>Citotria ternata</i> Flowers ..	435
Aphids New to India ..	390	British Association for the Advancement of Science ..	204
Appraisal of Newton's Mechanics and of Einstein's "Autobiography" ..	247	— Industrial Biological Research Association ..	40
Aquatic Sciences, Current Bibliography for (Rev.) ..	36	Bromination of 2, 4-Substituted Quinoline Derivatives ..	15
Archegonial Complement of <i>Botrychium lanuginosum</i> ..	388	Building Research, Conference on ..	243
Astral Molecules: Bands of BaO ($^1\Sigma - ^1\Sigma$) System ..	376	Butterworth Publications in Chemistry (Rev.) ..	277
Asymmetrical Factorial Designs Construction of ..	407	CALLUS Hair Length and Arrow Colour in Hybrids of <i>Saccharum</i> ..	188
Atlantic Undercurrent ..	445	<i>Calobryum</i> Nees—A Genus new to Indian Flora ..	22
Atmospheric Pollution ..	41	Calomel Reference Electrode ..	459
— Temperature Fluctuations ..	244	Cambridge University Press Publications (Rev.) ..	355
Auto-Triploid of Rice and its Progeny ..	432	Cancer Conference, All-India ..	243
Award of Research Degrees 39, 83, 123, 162, 243, 320, 360, 402, 444, 485		Carbonaceous Meteorites ..	245
<i>Bacillus thuringiensis</i> , Preliminary Trials with ..	29	Carbon Dioxide Estimations in Stored Grain as Indication of Condition ..	361
Bacterial Inoculants, Use of, in Indian Agriculture ..	325	Carbon-16, New Carbon Isotope ..	286
— Leafspot Disease of Jasmine ..	352	Carcinogenesis (Rev.) ..	481
Basic Principles of Fission Reactors (Rev.) ..	483	Carnegie Institution: Year-Book No. 59 (Rev.) ..	255
Bean Fly, A Pest of French Beans ..	192	<i>Cassia tora</i> : Local Lesion Host of Tobacco Mosaic Virus ..	353
Beautiful Climbers of India (Rev.) ..	482	Cellulose Research Symposium (Rev.) ..	358
Behaviour of Chromium Glycine Complex at the Dropping Mercury Electrode ..	141	Central Building Research Institute, Roorkee ..	124
Benguela Current ..	289	Cerebrospinal Leptospirosis in Buffalo Calves ..	147
Bibliography of Indology, Vol. I (Rev.) ..	82	Ceylon Tea Soils, Determination of Ammonia and Nitrate ..	17
Biennial Review of Anthropology 1960 (Rev.) ..	37	Chemistry and the Spectroscope ..	405
Binucleate Pollen Mother Cells in <i>Clitoria ternata</i> ..	306	— of Heterocyclic Compounds, Vol. XV (Rev.) ..	438
Biological Activities of Steroids in Relation to Cancer (Rev.) ..	241	— — Natural Products (Rev.) ..	35
— and Chemical Control of Pests (Rev.) ..	358	— — Terpenes (Rev.) ..	357
— Effects of Radiation ..	205	Chlorophyll Deficiency in <i>Nicotiana tabacum</i> ..	467
Biovular Follicle and Binuclear Oocyte in Five-Banded Squirrel ..	304	Chromosome Complement of <i>Trigonostoma cremulata</i> ..	150
Birbal Sahni Institute of Palaeobotany ..	402	— Numbers in Forage Grasses ..	393
Blight of Fennel in Rajasthan ..	65	— — — the Genus <i>Corchorus</i> ..	433
Blister Blight Disease of Tea Plants, Control by Nickel Chloride ..	57	— — — — <i>Curcuma</i> ..	194
Boiler Circulation Theory, Research into ..	133	— Number of Some Flowering Plants ..	73
Bone Mineral, Effect of Geological Ageing on Particle Size of ..	138	— s of Some Orchid Genera ..	75
Books Received: 38, 82, 122, 161, 202, 242, 281, 318, 359, 401, 443, 484		Coconut Water, Biochemical Composition of ..	362
Bradley Volume (Rev.) ..	280	Codeine Phosphate as Pretreating Agent ..	30
		Collagen, Structure of ..	127
		— Symposium on ..	49

PAGE		PAGE	
Collision of High Energy Particles with Light Nuclei	322	DARWIN'S Place in History (Rev.)	120
Colloid Chemistry, Introduction to (Rev.)	34	Descriptive Palaeoclimatology (Rev.)	440
Colloquium on Documentation	320	Determination of Ammonia and Nitrate in Ceylon Tea Soils	17
Colocasia Blight, New Host Plant of, Colour of the Sea	354	Development and Future of Physics	213
Comparative Biochemistry, Vol. I (Rev.)	285	— of Stomata in <i>Linum usitatissimum</i>	269
Conductimetric Study on the Precipitation of Lead Arsenites	357	Diamagnetic Anisotropy of Benzene	377
Conductive Organic Solids	140	— Susceptibilities of Isomeric Mono-substituted Nitrobenzenes	455
Control of the Maize Borers <i>Chilo zonellus</i> and <i>Sesamia inferens</i>	94	Di-Iodo Tetracarbonyl Iron II	259
— — Paddy Blast and Wheat Rusts	266	Distribution of Urease within the Seeds of <i>Cajanus indicus</i>	297
— — Safeda Muskmelon Fruit Rot	360	Dissymmetry Measurements of High Polymer Solutions	453
<i>Corchorus olitorius</i> and <i>C. capsularis</i> , Hybrids between	203	Diurnal Variation of F_1 Region Drifts at Waltair	9
<i>Corcyra cephalonica</i> Staint, Effect of Antibiotics on	67	Documentation, Colloquium on	320
Correspondence of Sir Isaac Newton, Vols. I and II (Rev.)	197	Dog-Tick <i>Rhipicephalus sanguineus</i> , on Prolonging the Longevity of, after Oviposition	265
Cosmic Ray Symposium, Proceedings of (Rev.)	76	Double-Cocoon Forming on <i>Philosamia ricini</i> and <i>Antheraea assama</i>	274
Cotton in India, Vols. II, III and IV (Rev.)	420	Double-Pass Jamin Interferometer	163
. . . . 81, 201, 441		Double Phlox	162
Coumarin as Growth Stimulator of Maize Seedlings	448	— Star Astronomy (Rev.)	165
—, PMR Spectrum of	331	Dover Publications in Applied Mathematics (Rev.)	77
Criteria for Grading Resistance of Sugarcane Varieties to Red Rot	425	Downy Mildew of Maize, Perpetuation of, on <i>Kans</i>	114
<i>Cryptococcus</i> , on the Genus, in India	224		
— <i>neoformans</i> from Patients in Poona	180	EARTH'S Crust	89
Cryptogams of Bhopal, A Note on	31	— under Indian Ocean	272
Crystal Structure of He^4 and He^3	320	Earth Tides	410
— — of Lanthanum Magnesium Nitrate	53	Earthworm Eggs, Metachromasia of	422
— — of Rhodites and Ruthenites	52	Echitamine Iodide, Structure of	5
— —s Supplement V (Rev.)	158	Ecological Problems in Tropics, Symposium on	41
C.S.I.R.O. Research Review 1959-60 (Rev.)	400	Ecology of Acantharious and Circulation of Sr. in the Sea	205
<i>Cucumis</i> Virus 2 C in Mosaic Infected Bottle-Gourd	273	Effect of Beta Radiation from P^{32} on <i>Bracon gelechiae</i>	391
Cultivation of Algae in Heavy Water	8	— of Electrical Oscillations on the Electric Field in the Glow Discharge	98
Cup Leaf—A New Leaf Mutant in <i>Rai</i>	27	— of Fast Neutrons on Sexuality in Castor	305
Current Bibliography for Aquatic Sciences (Rev.)	36	— of Flower Suppression and Grafting on Nicotine Content in Tobacco	234
— Problems in Animal Behaviour (Rev.)	239	— of Gammexane on Flavoprotein Enzymes of Rat Liver	416
<i>Cylindrocycladium</i> Parasitic on Tea Roots, A New Species of	186	— of Geological Ageing on the Particle Size of the Bone Mineral	138
Cytogenetics and Plant Breeding (Rev.)	280	— of Gibberellic Acid on Berseem	203
— of an Interspecific Hybrid in <i>Oryza</i>	189	— of Growth-Regulating Substances of Water Hyacinth Root Extract on Jute	428
— of the Intergeneric Hybrid <i>Vaccaria grandiflora</i> \times <i>Saponaria vaccaria</i>	327		
Cytological Observations on the Indian Species of <i>Comelinaceæ</i>	310		

PAGE		PAGE	
Effect of IAA and Tiba on Vernalized Paddy	395	FAST Nutron Physics (Rev.)	34
— of Infection of <i>Sphacelotheca schweinfurthiana</i> , on Spikelet Structure in <i>Erianthus munja</i>	22	Fatty Oil from <i>Nigella damascena</i> Seeds	55
— of Indole Acetic Acid on the Nitrogen and Carbohydrate Metabolism of Excised Wheat Leaves	24	Feeding Mechanism of <i>X. cheopis</i>	465
— of Lucerne Supplement to Rice Diet on Circulating Haemoglobin and Plasma Proteins of Rats	56	Fern Rusts from India	308
— of Moisture Content of Food Materials on Growth and Sex Ratio in <i>Corcyra cephalonica</i>	104	FERROELECTRICS	85
Ejaculatory Duct in <i>Empoasca devastans</i>	31	Fertilizers and Rice Production in India	124
Elastic Scattering of 426 MeV Electrons by Li-6	51	Fertilizer Value of Dicalcium Phosphate	261
Electricity from Flames	323	Fibre Content in Hemp and Sunn, Application of Gibberellins	177
Electronic Transition Moment and Vibrational Temperature	216	Fibrous Thickening in the Anther Epidermis of <i>Wormia burbridgei</i>	426
Electrons in the Primary Cosmic Radiation	206	Finger-Tip Patterns of the Car Nicobarese	103
Electrophoresis, a Simple Method of Reducing Variations of Current	228	Fish from a Depth of 7,580 Metres	41
Element 103, Lawrencium	283	Fishing Net Twines, Effect of Boiling	319
Embelin, Some Reactions of	333	Flavylium Salts of Anthocyanidin Type, Preparation of	287
Embryology of <i>Knoxia corymbosa</i> Willd.	190	Flint × Dent Maize Hybrids Give Increased Yields	233
Emplacement of Pegmatites in Kondapalle Area	20	Floral Morphology of <i>Curcuma longa</i>	274
<i>Empoasca devastans</i> , Modification of Ejaculatory Duct in	31	Fluid Inclusions in Barite from Pulinvendla	263
Endotrophic Sporulation among Species of <i>Streptomyces</i>	145	Fluoride Complexes of Uranium (IV) and Thorium with Hydrazine and Hydroxylamine	293
Enhanced Reduction Efficiency of Sodium Borohydride in the Presence of Titanium Tetrachloride	218	Folin-Phenol Reagent for Measurement of Leaf Proteins	58
Enzyme Make-up of <i>Alternaria</i>	450	F ₁ Region Drifts, Diurnal Variation of Food Preservation, Use of Ionising Radiations for	9
Epicomum nigrum Link: A New Report from Indian Soils	69	Formation of Mn (II)—Formate Complex	290
Epimerisation at the C ₄ -Centre of a Flavan-3 : 4-Diol	142	Forest Development for India	256
Error Correcting Codes (Rev.)	480	Formation of Mn (II)—Formate Complex	14
Estimation of Galacturonic Acid by Paper Chromatography	337	— of Red Rot Acervuli on Sugarcanes	63
— of Selenium with Thiourea	336	Fortschritte Der Hochfrequenztechnik, Vol. IV (Rev.)	159
Etching of Antimony Single Crystals	293	Foundations of Modern Analysis (Rev.)	117
<i>Euproctis lunata</i> Walker, Multiparasitism in Eggs of	69	Free Radicals in Crystals	369
Evolution as a Test for Ethics (Rev.)	214	Fungi Causing Spoilage of Refrigerated Poultry Meat	64
Extracting Electricity from Flames	323	—, Two New Genera, from Tertiary Coal Beds of Malaya	112
Extraction of Ascorbic Acid from Potatoes, Low Cost Reagent for	319	Furfural, Preservation of Alcoholic Solution of	198
Extractive Metallurgy of Copper, Nickel and Cobalt (Rev.)	397	GAGARIN, Yuri Alexeyevich, First Cosmonaut	136
		Gall Midge Associated with Sugarcane Inflorescence	350
		Gamma Radiation to Control Timber Pest	282
		Gas Chromatography (Rev.)	438
		General Physical Science (Rev.)	483
		— Zoological Microtechniques (Rev.)	161
		Generation of Optical Harmonics	403

PAGE	PAGE
Genetics and Plant Breeding, Indian Society of	Homopterocarpin, Synthesis of a Receptacle of 218
— of Dwarf Growth in Common Wheat	Humanity of Man 324
Geological Society of India Journal	Hydrogen Cloud of Terrestrial Origin 486
Geology of India and Burma (Rev.)	— Maser 41
Germination of Grape Hybrid Seeds by Chilling	Hydrospheric Origin of Lunar Surface Features 83
Gibberellin Induced Parthenocarpy in Guava	Hyperon Stars 321
Glucose-6-Phosphate Dehydrogenase, Deficiency of	I.C.A.R. Grant to Current Science 123
Glycogen Content of Marine Animals	Ice, Vitreous, Structure of 164
Gossypium hirsutum, Viability and Fertility of Monosomics in	Illustrated Genera of Wood Decay Fungi (Rev.) 481
Granites of Hyderabad, Pink and Gray	Improved Basal Medium for the Microbiological Assay of Riboflavin using Lactobacillus caseii 418
Grasses of Burma, Ceylon, India and Pakistan (Rev.)	Impulse Voltage Testing (Rev.) 356
Gravimetric Determination of Cerium (IV)	Index of Chemistry Films (Rev.) 37
Groundwater in the Submontane Tracts of Uttar Pradesh	Indian Academy of Sciences: XXVI— Annual Meeting 3
Growth Regulators and Rooting of Cuttings in Antirrhinum majus	— Botanical Society 33
Guide-Book to Biochemistry (Rev.)	— — — Memoris 444
Gynoecium in the Ovary of Rhinanthus major	— Essential Oils (Rev.) 316
HAEMATOXYLIN Squash Technique for Study of Rat Liver Cells Nuclei	— Journal of Microbiology 205
Hand-Book of Textile Testing and Quality Control (Rev.)	— Pharmaceutical Congress Association 162
Haplosporella, a New Species of	— — — 282
Harb. I.M.I. Hand-Book (Rev.)	— Science Congress 4
Hardboards from Lantana	— Standards Institution, XIII Annual Report 281
Heavenly Clock (Rev.)	India's Population According to 1961 Census 174
Helicostylum pyriforme on Sugarcane in India	Indigenous Drugs, Symposium on 40
Hermaphroditism in the Catfish Mystus vittatus	Inducement of Anther Dehiscence in a Sugarcane Variety 113
Heterodera major, a Simple Method of Hatching of Cysts of	Industrial Electric Furnaces and Applications (Rev.) 118
Heteropolysaccharide from Pasteurella multocida	— Spectroscope 409
Heylandia latebrosa DC.—A Promising Legume	Influence of Host Plants on the Amino-Acid Make-up of Santalum album Linn. 417
High Energy Physics (Rev.)	Information Retrieval and Machine Translation, Parts I and II (Rev.) 442
— Intensity Magnet	Infra-Red Methods, Principles and Applications (Rev.) 198
— Resolution PMR Spectrum of Coumarin	— Molecular Emission Spectroscopy by Michelson's Interferometer 362
— — Raman Spectroscopy of Gases	— Physics—International Research Journal 284
— Stretch Paper from Sisal Fibre	— Spectroscopy, Recent Advances in 1
History of Science and Engineering in the Lands of the Orient (Rev.)	— Spectra of Water 43
Homology Theory—An Introduction to Algebraic Topology (Rev.)	Inheritance of Hairy Character on Black Gram Pods 434
	— of the Retuse Leaf Apex in Cross between Crotalaria striata and C. mucronata 476

SUBJECT INDEX

	PAGE		PAGE
Insecticidal Properties of <i>Zanthoxylum alatum</i>	223	Leaf Distorting Virus Disease of <i>Jatropha curcas</i>	345
Institute of Physics and Physical Sciences	320	— Protein in Nutrition	298
— — — Society	213	Leafspot Diseases	343
— — — — Awards	40	Lectures on Linear Algebra (Rev.)	479
— — — — Symposia	402	Leh: buchen Der Theoretischen Physik (Rev.)	158
— of Chemists	204	Liesegang Rings, Influence of Adsorbent on the Formation of	335
Insulin (Rev.)	317	Light Amplifier Tube to Photograph Cosmic Ray Tracks	86
Intensity Sensitivity of Human Eye ..	206	Living Body (Rev.)	119
Interplanetary Magnetic Field and the Auroral Zones	163	Locust	42
International Conference on Neurosecretion	363	Long-Distance Signals via Moon	124
— — — Physics of Semiconductors	320	Low Pressure Mercury Lamp	163
— — — Protozoology	364	— Temperature Transformer	487
— Congress of Pure and Applied Chemistry	83	Lunar Crater Alphonsus, Origin of C ₂ Molecules Observed	404
— — — of Radiation Research	123		
— Control of Investigations of Rare Meteorites	212		
— Rubber Conference	402	MAGNETISM and Molecular Structure: Estimate of Metal-Nitrogen Bond ..	456
— Society for Tropical Ecology—1962 Symposium	162	Magnetohydrodynamics; Electricity from Flames	323
Introduction to Astrodynamics (Rev.)	315	Malacological Congress, First European ..	243
— to Biochemistry (Rev.)	278	Malvaceous Species, Meiotic Studies in ..	26
— to Electronic Theory of Organic Compounds (Rev.)	199	Mandelic Acid, Reaction of, with Sodium Molybdate and Tungstate	386
— to Homological Algebra (Rev.)	117	Mango Bunchy-Top and the Eriophyid Mite	114
— to Laplace Transformation (Rev.)	398	Manned Space Flight, United States' Success in	167
— to Physical Chemistry (Rev.)	281	<i>Marasmia trapezalis</i> , Natural Enemies of ..	72
— to Statistical Thermodynamics (Rev.)	275	Marine Fossiliferous Lower Eocenes ..	360
— to Quantum Field Theory (Rev.)	76	— Wood-Borer, <i>Xylophaga</i> from Bay of Bengal	464
Iodometric Amperometric Determination of Copper (II)	12	Mechanics (Rev.)	314
Ionising Radiation for Food Preservation	290	Mechanisms in Radiobiology, Vol. II (Rev.)	238
Irreversible Polarographic Waves, Application of, to Reduction of Brilliant Green	175	Medicinal Chemistry (Rev.)	122
ISI Hand-Book of Quantities (Rev.)	38	Meiotic Studies in Some Malvaceous Species	26
JETS and Rockets (Rev.)	77	<i>Meloidogyne javanica</i> (Trueb), Host Range of Sugarcane Root-Knot Nematode	149
Journal of Catalysis	485	Memoirs of the Indian Botanical Society	444
— of Experimental and Molecular Pathology	485	Mercuration of Compounds Containing Reactive Methylene Group	333
— of Theoretical Biology	204	Mercurochrome as a Spray Reagent	144
KYANITE-Quartzite, Occurrence of	19	Meson Physics (Rev.)	355
Kyushu Earthquake—Gravity Record at Hyderabad	183	Mesta as a Border Crop on Sugarcane Plantation	206
LAC Insect, <i>Kusmi</i> Strain of	152	Metabolic Pathways, Vol. I (Rev.)	277
Lady Tata Memorial Trust Scholarship	243	Metabolism of Oral Tissues (Rev.)	279
Land and Freshwater Mollusca in the Collection of the Madras Government Museum (Rev.)	80	Metacercaria of <i>Aphanurus</i> from a Copepod <i>Acrocalanus gracilis</i>	225
Lawrencium, Element 103	283		

	PAGE	PAGE	
Metacercaria of <i>Eumegacetus</i> in Dragon-Fly Naiads	303	New Moons	403
Metachromasia of Earthworm Eggs	422	New Standard for the Metre	283
Meteorites, Age of	84	Nicotinamide Deamidase in Germinating Pulses	461
—, Carbonaceous	245	Nimrod Injector, Successful Operation of	406
—, International Control of Investigations of	212	Nitrogen and Carbohydrate Metabolism of Excised Wheat Leaves, Effect of Indole Acetic Acid on	24
Methods of Biochemical Analysis, Vol. VIII (Rev.)	238	— Content of Wood-Boring Martesia	185
Microbial Disease of <i>Ophiusa corona</i>	390	Non-Linear Systems, Some New Concepts in	134
— Genetics, Symposium (Rev.)	242	Notulæ Embryologicæ: Functions of Endosperm in <i>Avicennia officinalis</i>	424
— Reaction to Environment (Rev.)	441	Nuclear Magnetism, Principles of (Rev.)	446
Microbiological Assay of Riboflavin using <i>Lactobacillus casei</i>	418	Nucleolar Number and Polyploidy Level	476
Micro-Chamber for Incubation of Plant Section and its Growth Rate Measuring	264	— Scattering of High Energy Nucleons, Absorption Cross-Sections for	215
— Elements in Human Body	42	345 OCCURRENCE of Acrasiales in Indian Soils	24
Microfungi from Usar-Soils of India. New Records of	282	— of Amino-Acids and Allin in the Indian <i>Alliums</i>	338
Micro Hydel Sets for Power Generation	487	— of C ₈ Units in Xanthones	90
Micrometeorite Layer at High Altitudes	14	— of Intracortical Roots in <i>Bambusa</i>	308
Mn (II)—Formate Complex, Formation of	189	— of Kyanite-Quartzite from Varuna Schist Belt, Mysore	19
Mode of Infection in Sawan Smut	246	— of Root-Knot Nematodes on Betel-vine	351
Mohole, U.S. Project	261	— of Twin Embryo-Sacs in <i>Capparis aphylla</i>	187
Moisture Content of Parboiled Rice Determination by Immersion Method	383	Ocean Basins and Continents, Origin of	321
Molasses, Acetic Fermentation of	207	Odour and Molecular Vibration	322
Molecular Electronics	219	Organic Electronic Spectral Data, Vols. I and II (Rev.)	275
Molybdate-Tungstate Antagonism in <i>Neurospora crassa</i>	131	Origin of Lunar Domes	446
Morphogenetic Responses of the Thallus of <i>Marchantia</i> to Growth Substances	67	— of Ocean Basins and Continents	321
Morphology, Cytology and Breeding Behaviour of Hybrids between <i>Corchorus olitorius</i> and <i>C. capsularis</i>	300	— of Vempalle Shales and Limestones in Cuddapah Basin	386
— of Onge Foot	469	Ostracoda, Discovery of, from the Upper Cretaceous Bagh Beds	341
— of the Pollen Grains of <i>Cucurbita</i>	313	— Occurrence of, in Rocks of Paleocene Age	222
Moss Flora, Polish Loess, Compositions and Adaptation Modifications of	69	Ovine Abortion due to <i>Toxoplasma gondii</i>	299
Multiparasitism in the Eggs of <i>Euproctis lunata</i>	109	Oxidation of Thiocyanate with Chloramine-T	176
Multiple Allelism for Petal Colour in <i>Linium grandiflorum</i>	306	Oxygen Intake by Rice Plant Roots	445
Multivariable Control Systems in the Light of Symmetrical Components		PACHYTENE Analysis in <i>Japonica indica</i> Rice Hybrids	70
NATIONAL Physical Laboratory, Annual Report for 1960	292	Pachytene Analysis in <i>Melilotus segetalis</i>	232
Natural Control of Potato Tuber Moth	319	Paint Technology Manuals (Rev.)	398
Nepal (Rev.)	80	Paper Chromatographic Methods of Separation of Cu, Ni and Co	10
Neurosecretion—Third International Conference	363		

PAGE	PAGE
Parasitic Nematodes of Sugarcane in Bihar	193 Prawn Processing, Use of Chilled Water in
Pasteurella multocida, a Rare Serotype of, Causing Pneumonia in Sheep ..	267 <i>Premna resinosa</i> Schau (Verbenaceæ), An Addition to Indian Flora ..
Pebrine Germ of <i>Philosamia ricini</i> Hutt., Infective Capacity on <i>Bombyx mori</i>	28 Preparative Methods of Polymer Chemistry (Rev.)
Pegmatites, Emplacement of, in Konda-palle Area	20 Presoaking of Cereals in Antibiotics ..
Pelagic Fish Spawn, on the Occurrence of	28 Prevention of Flowering in Sugarcane ..
Peptide, a New, from Brain	20 Principles of Animal Virology (Rev.) ..
Perfumes Cosmetics and Soaps (Rev.)	61 — of Electrolysis (Rev.)
Permo-Carboniferous, Discovery of Marine, in the Western Rajasthan	296 — of Modern Physics (Rev.)
Perspectives in Virology, Vol. II (Rev.)	160 — of Nuclear Magnetism (Rev.)
Perspex Electrets	262 Proceedings of the Centenary and Bicentenary Congress of Biology, Singapore, 1958 (Rev.) ..
Pertussis Vaccine, a Modified Medium for Production of	481 — of the Cosmic Ray Symposium, 1960 (Rev.)
Petrified Monocotyledonous Leaves from the Tertiary of Madhya Pradesh	11 — of the International Congress of Mathematicians, 1958 (Rev.) ..
Petrology for Students (Rev.)	263 — of the Natural Rubber Research Conference (Rev.)
Peyronellæa, a New Species of	342 Progress of Chemistry for 1959, Annual Report (Rev.)
Photolytic Preparation of Uranium (IV) Sulphate Complexes	201 — in Endocrinology (Rev.)
Photosynthesis	343 — in Inorganic Chemistry (Rev.)
Physical Chemistry (Rev.)	380 Proton Magnetic Resonance in Sesamin and Asarinins
— Principles of Astronautics (Rev.)	45
Physics of the Atom (Rev.)	483 Protozoology—First International Conference
Piedmontite from Goldongri Manganese Mine	398
Piezometer for the 100-Kilobar Region	236 Pteridophytes of Nagpur
Pistacite from the Granites of Putalappattu	223
Plant Nematodes, their Bionomics and Control (Rev.)	283 QUALITATIVE Organic Analysis (Rev.) ..
Plasma Diode	295 RADAR Meteorology (Rev.)
— Pinch, Miniature Sun Created by	399 Radioactive Wastes Fixed in Glass
— Protein, Vols. I and II (Rev.)	245 Radioactivity for Pharmaceutical and Allied Research Laboratories (Rev.) ..
Polyarthritis in Sheep in India	251 Radiofrequency Spectroscopy, Varenya Summer School
Polyembryony in Mulberry	35, 120 295, 119
Polyhaploid Plant of <i>Sorghum halepense</i>	59 Radioisotopes in Biology
Polyvinyl Chloride Coating for Glass Bottles	203 Radio Waves from Saturn
Possible Parent Substances for the C ₂ Molecules in the Alphonsus Crater	347 Rafi Ahmed Kidwai Memorial Prize
Potato Root-Eelworm <i>Heterodera rostochiensis</i>	205 Rain Formation, Nuclei for
Potential Constants and Termodynamic Properties of IF ₅ and IF ₇	40 Raman Chair in Physics in the Madras University
— Constants and Thermodynamic Properties of SiBr ₃ I	404 — Spectrum of Deuterated Methane (CD ₄)
— of Cyclopropane and Cyclopropane d ₆	187 — — of Gaseous CF ₄
Powdery Mildew on <i>Gmelina arborea</i>	413 Raptakos Medical Research Fellowships
	377 Reaction of Shadow in <i>Dasychone Cingulata</i>
	332 —s of Epichlorohydrin with phenols
	155 Reactor Handbook, Vol. I (Rev.)

PAGE		PAGE	
Real Objective Plane (Rev.) ..	314	Segregation for Lanky and Normal Seedlings in Sorghum	188
Rearing of more than One Generation of Univoltine Silkworms	435	Seismic Exploration in the Cauvery Basin of Madras State	168
Recent Advances in Infra-Red Spectroscopy	1	Seminar on Electrochemistry	282
Red-Shift, A large	171	Separation of Rare-Earths	221
Report of the Rothamsted Experimental Station for 1959 (Rev.)	121	— of Uranium from Sodium-Diuranate by Photolysis	54
Representation of Primes by Quadratic Forms (Rev.)	119	Sewage and Activated Sludge as Source for Isolation of <i>Azotobacter agilis</i> ..	382
Reproduction Paper for Printing Chromatogram	39	Sex Differentiation and Development (Rev.)	317
Resistance of Paddy Varieties to Blast ..	272	Shepard, Alan, U.S. Astronaut ..	167
Response of Hybrid Maize to Zinc Fertilisation	473	Silkworms, Rearing of Univoltine ..	435
Reversions in Drug Resistance of <i>Vibrio cholerae</i>	417	Simultaneous Occurrence of <i>Tilletia foetida</i> and <i>Anguillula tritici</i> in Wheat	307
Rhizosphere Microflora of Citrus Plants, Influence of Streptomycin Spray ..	25	Single Value Measure for Soil Texture ..	106
Rhodites, Crystal Structure Data of Rocket to Venus	52	Sixth Degree Cubic Field, Effect of, on Rare-Earth Ions in Crystals ..	217
Rocks at Pandava Falls in Panna State ..	44	Skeleto-Muscular System of the Sucking Pump of <i>Papilio demoleus</i> ..	301
Role of Plants in the Movement of Phosphorus by Radioactive Isotopic Studies ..	56	Soil Fungi, Two New Records ..	231
Root-Knot Nematode, Screening Sugarcane Varieties for Resistance to — — — s on Betelvine	180	— Texture, Single Value Measure for Solar Corona, Long Wavelength Spectrum of	106
Root Parasite <i>Aeginetia indica</i> ..	349	— Energy	130
Rotational Multiplets in the Oscillation Spectrum of the Earth	351	— High Voltage Electricity Generator ..	94
Rotating-Wall Laboratory for Building Research	244	Solution of Equations and Systems of Equations (Rev.)	39
Rotifers from Shallow Ponds in Delhi ..	322	Sound Waves Trapped in the Solar Atmosphere	437
Royal Institute of Chemistry: Monographs for Teachers (Rev.) ..	444	Space Radio-Telescope	486
Ruminant Endosperm in the Canellaceæ ..	268	— Trajectories (Rev.)	244
Russia Sends First Man into Space ..	358	Spark Chamber	479
SALT Pseudomorph Shales from the Upper Vindhyan	344	Spawning Grounds of Indian Shad, <i>Hilsa ilisha</i> in Freshwater Regions ..	404
Sanasar Cirque	136	Spectrum of Sun from High Flying Aircraft	373
Sand Culture Technique for Study of Trace Element Deficiencies ..	163	<i>Sphacelotheca schweinfurthiana</i> , Effect of Infection of, on Spikelet Structure in <i>Erianthus munja</i>	284
Sands of Cape Comorin, Heavy Accessory Study of	147	<i>Sphaeropsis</i> knots on Lime in Rajasthan ..	22
<i>Sanitalum album</i> Linn. Influence of Host Plants on the Amino-Acid Make-up of	427	<i>Sphaerotheca</i> on <i>Euphorbiaceæ</i> from Hyderabad	110
Scientific Documentation, Regional Seminar	384	Sporophyte of <i>Jungermannia viridis</i> ..	433
Screening of Rice Varieties for Resistance to Foot-Rot Disease ..	417	Stacking Faults in Gold-Cadmium Alloy ..	430
— Sugarcane Varieties for Resistance to Root-Knot Nematode	83	Starch Content of <i>Saccharum spontaneum</i> Variants	379
Second Course in Statistics (Rev.) ..	145	<i>Stemphylium</i> and <i>Pseudostemphylium</i> ..	113
	349	Steroids as Ice Nucleators ..	423
	399	Stochastic Processes, Introduction to (Rev.)	446
		Stomata in Coleoptile of <i>Oryza sativa</i> L.	33
			30

PAGE		PAGE	
Streblus asper Lour., Chemical and Pharmacological Examination of ..	420	Syntheses of O-Trimethyl Alloteracacidin and O-Trimethyl Alloisoteracacidin ..	101
Streptomycin and Kanamycin, Cross-Resistance of ..	462	Synthesis of Racemate of Homopterocarpin ..	218
Stromatolites in Lower Cuddapah Limestones ..	221	— of 4:5 Dihydroxy-Coumarin ..	54
Structural and Topographic Trends in Kondapalle Area ..	115	— of N-Methyl-2-Azabicyclo (3,3,0) Octane ..	414
— Materials in Chemical Technology ..	445	— of Thioureido-Benzophenones ..	219
Structure and Function of Muscle, Vol. II (Rev.) ..	316	— of Thioureido-Triphenylmethanes ..	415
— and Ontogeny of Epidermal Appendages of <i>Ocimum basilicum</i> ..	471	— of p-Benzohydroquinone-1-C ¹⁸ ..	370
— of Collagen ..	127	Synthetic Ion-Exchangers (Rev.) ..	397
— of Echitamine Iodide ..	5		
— of Vitreous Ice ..	164	TABLES of the Riemann Zeta Function (Rev.) ..	314
Studies in Indian Medicinal Plants Used in Ayurveda (Rev.) ..	399	Tamarind Leaves, Organic Acid Metabolism in ..	381
— in <i>Physalia physalis</i> (Rev.) ..	240	Taxonomy of Earthworm in India ..	361
— on the Rhizosphere Microflora of Citrus Plants as Influenced by Streptomycin Spray ..	25	Tenth Symposium of the Society for General Microbiology (Rev.) ..	242
Sugarcane Mite on Jowar ..	107	Termites Infesting Sugarcane Crop ..	229
—, Prevention of Flowering in ..	211	Tetramerous Flower of <i>Abutilon indicum</i> ..	403
Sulphonamidoiodophthaleins ..	460	Text-Books in Mathematics (Rev.) ..	197
Sulphur Fumes from Chemical Plants, Removal of ..	206	Theoretical and Applied Mechanics Sixth Congress on, ..	123
Summer School on Radiofrequency Spectroscopy, Varenna ..	7	— — — —, Seventh Congress ..	360
Superconductors for Strong Magnetic Fields ..	244	— Physics in the 20th Century: Memorial Volume to W. Pauli (Rev.) ..	315
Superposable Pictures of Chromosome Structure of <i>Allium cepa</i> in Feulgen and Hæmatoxylin Squashes ..	172	Theory of Differential Equations (Rev.) ..	236
Swim-bladder Structure of Deep-Sea Fishes (Rev.) ..	440	— of Optics (Rev.) ..	236
Symposia on Vacuum Physics and Nuclear Physics ..	402	— of Probability (Rev.) ..	355
Symposium on Carbohydrate, Cellulose and Cellulose Industry ..	282	— of Universe, Explosive Evolution ..	125
— on Collagen ..	49	Thoracic Glands in <i>Mylabris pastulata</i> ..	111
— on Ecological Problems in Tropics ..	41	Three-Electrode Trigger in the Spectral Study of Exploding Wires ..	257
— on Explosives ..	96	Throwing Power of Lead Nitrate Bath for Anodic Deposition of Lead Dioxide ..	139
— on Ferrow-Alloy Industry in India ..	162	Thyro-Gonad-Adrenal-Pituitary Relationships, Proceedings of the Symposium on (Rev.) ..	37
— on History of Sciences in India ..	40	Thyroid Gland (Rev.) ..	241
— on Indigenous Drugs ..	204	Titov, Major Gherman, Russia's Second Cosmonaut ..	365
— on Low Temperature Carbonisation of Non-Caking Coals ..	444	Titration Coulometer ..	13
— on Plant Tissue and Organ Culture ..	108	Tobacco, Nicotine Content in, Effect of Grafting on ..	234
— on Production and Utilisation of Medical and Aromatic Plants in India ..	243	<i>Tolyposporium ehrenbergii</i> (Kuhn) ..	486
— on Scombrid Fishes ..	485	Tooth Enamel Protein, Nature of ..	85
— on Thyo-Gonad-Adrenal-Pituitary Relationships (Rev.) ..	37	Top-Shoot Borer of Maize, New Host Plants of ..	109
		Total Soluble Salts in Black Clayey Soils ..	108
		Toxicology—Mechanisms and Analytical Methods, Vol. I (Rev.) ..	200
		Transition Probabilities in Astral Radicals: LaO (B → X) System ..	137

PAGE		PAGE	
Translocation of Radioactive Schradan in Plants	105	Vegetative Propagation of Cultivated Rice	474
Treatise on Analytical Chemistry: Part I (Vol. II) (Rev.)	396	Venus, Radio Location Studies of .. .	246
— on the Analytical Dynamics of Particles and Rigid Bodies (Rev.) ..	236	Viability and Fertility of Monosomics in <i>Gossypium hirsutum</i>	155
Tribes and Castes of Nilgiri Hills, Dermatoglyphic Study of	463	— of Stored Seed Wheat	466
Tropical Ecology, 1962 Symposium ..	162	Vilangin—A New Constituent of <i>Embelia ribes</i>	259
Turkmenia's Academy of Sciences, Tenth Anniversary of	320	Virus Disease of <i>Odontonema nitidum</i> "Vostok"—Russia's First Manned Satellite	431
2:4-Dinitrophenylhydrazones of some Flavanones	414	— II—Russia's Second Manned Space-Ship	136
2-Steryl Derivatives of 4(3)-Quinazolones as Potential Antimalarials and Amœbicides	179	WATER and Agriculture (Rev.) .. .	365
ULTRASONIC Velocity in Inorganic Solutions and Melts	454	Whistlers	81
Universe, New Theory of	125	White Dwarf Cluster, Discovery of ..	125
Unusual Mode of Egg-Laying in <i>Trochoceras granarium</i>	230	Wilting of Big Rain Trees in Calcutta ..	321
Up-take and Reduction of Bromate by Wheat Roots	102	Wind as a Source of Energy in India ..	307
Urea-Form, A New Fertiliser	182	World Population Trends	95
VANADIUM-Bearing Titaniferous Magnetites	183	XANTHOHUMOL, Constitution of .. .	445
Varennna Summer School on Radiofrequency Spectroscopy	7	X-Ray Microscopy (Rev.) .. .	333
Variation among Rice Varieties in Regard to Germination under Submersion and Heat Stability of Chlorophyll	235	ZEEMAN Effect, Mechanical Counter-part in Free Oscillations of Earth ..	315
		Zeiss Instruments at the 1961 Leipzig Fair	322
		Zone Plate Spectrometer for the Far Infra-red	96
		125	

RECENT ADVANCES IN INFRA-RED SPECTROSCOPY*

DR. EARLE K. PLYLER

National Bureau of Standards, Washington, D.C.

INTRODUCTION

INFRA-RED spectroscopy has entered a new period of rapid progress as a result of the great technical advances that have been made in recent years in the instrumentation employed. These advances have been both with respect to increasing the resolving power of the spectrometer and with respect to mechanisation and speed of recording. Modern high-resolution infra-red spectrometer is the outgrowth of the earlier instruments used by such pioneer workers in this field as Rubens and Coblenz more than fifty years ago.

The present-day high-resolution grating spectrometer has a resolution of 0.02 cm.^{-1} . This level of resolution has been possible by the development of lead sulphide detectors and high precision optical parts. Recent work on lead sulphide photo-conductive cell established it as a tool of exceptional sensitivity in infrared spectroscopy. Its use has enabled a gain of at least ten times in resolution to be made, while the fast response of this detector has led to its application in infra-red for the rapid recording of spectra. The infra-red spectrometer which has been constructed in the Bureau of Standards has 10-inch gratings which are used double pass. The spectrum of the molecules is measured to a high precision by using the fringe system of a Fabry-Perot interferometer.

MOLECULAR DATA FROM INFRA-RED STUDY

Apart from its chemical and industrial applications the study of infra-red spectra, especially the high-resolution spectra, is of fundamental importance in obtaining data on the mechanics of simple molecules. Vibrational spectra are the only source of our knowledge of the interatomic forces which hold molecules together and govern the relative motions of their atoms. In recent years high-resolution spectra of many molecules have been measured and the molecular dimensions determined. One recognised method of checking the assignment of vibrational frequencies and obtaining more precise

information on inter-atomic distances and angles in molecules is to study the infra-red spectra of deuterated molecules. The replacement of hydrogen by deuterium in molecules containing hydrogen results in specific vibrations moving to lower frequencies, thus serving to check and confirm assignments, evaluate more distances and check force fields. For example the spectrum of ethylene and totally deuterated ethylene made it possible to obtain an exact value for the angle of the CCH atoms. It was found to be 116.5° instead of the previously accepted value of 120° . Similar measurements have been made on methane and deuterated methane. One interesting feature of the methane spectrum is the large number of lines in the bands when high resolution is employed. In the region between $2,400$ and $3,200 \text{ cm.}^{-1}$ several bands were observed and 2,600 lines of methane were measured. In view of the fact that there are a large number of lines to be recorded and also because of the high dispersion involved considerable time is required to record the spectra. For the methane spectrum between $2,400$ and $3,200 \text{ cm.}^{-1}$ 12 hours of time and 480 ft. of recorder paper were needed to observe the spectrum.

PRECISION STUDIES OF DIATOMIC MOLECULES

Recently some attention has been given to the precision study of diatomic molecules. The carbon monoxide spectrum measured to a high precision (error 1 part in a million) has enabled the velocity of light to be determined to a degree of accuracy never attempted before by this method. The velocity is calculated by combining the wave numbers obtained from infra-red measurements with the frequency measurements from microwave data. The value of the velocity of light obtained by this method was $c = 299793 \pm 3 \text{ Km./sec.}$ This value agrees closely with the values obtained by other methods.

Other diatomic molecules have been measured to a high precision so that there are now available a number of accurate wave number values which are useful for the calibration of spectrometer. The region from 650 to $4,000 \text{ cm.}^{-1}$ (2.5 to 16μ) has now about 1,000 calibration wave numbers for use of spectroscopists in many laboratories. Work is in progress for extending calibration from 16 to 100 microns.

* This article is based on the lecture given at the Symposium on "Vibration Spectra of Molecules and Crystals" at the 26th Annual Session of the Indian Academy of Sciences, held in Madras, on December 27, 1960.

SPECTRA OF TRIATOMIC MOLECULES

Researches have been carried out on the spectra of several triatomic molecules. Infra-red spectra are the best means of determining the structure of small molecules. For example, nitrous oxide (N_2O), carbon dioxide, carbon disulphide, hydrogen cyanide are linear molecules, while H_2O , NO_2 , SO_2 have a triangular structure. The difference in the spectra of these two classes of molecules is great when measured under high resolution. The linear molecules, except for a small convergence, have equally spaced lines while the nonlinear molecules have a very complex spectrum. For example the ν_1 and ν_3 bands of H_2O in the region of $3,500\text{ cm}^{-1}$ have a spectrum which has been resolved into 2,000 lines. The analysis of molecules of low mass is not difficult except for the solution of the interactions which displace the spectral lines from their normal position. The Fermi interaction is the most common type.

Under low resolution a linear molecule has a very simple spectrum. With high resolution all the Q branches can be resolved and hot bands are observed overlapping the main band. In addition there are usually isotopic bands in the same region and the resultant spectrum is somewhat complex. However, with sufficient resolution the different bands can be separated and a fairly complete analysis of the spectrum can be made. There are now known about 90 bands of N_2O arising from different levels and a fairly complete form of the potential function can be obtained. It is now possible on the basis of measurements of the last five years to give a good description of the energy levels of many triatomic molecules.

Usually the spectra of linear and of spherical top type molecules show approximately evenly spaced lines. With high resolution the difference between the spectra becomes apparent since the spherical top molecules, such as CHD_3 , show K type structure. When the K structure is resolved there is possible to form many equations for determining the molecular constants and the precision of the values is increased.

INFRA-RED AND RAMAN SPECTRA

Study of high-resolution spectra in the region from 2 to 10μ has added much information to the subject of molecular structure. With the information obtained from the Raman spectra as a complement to the infra-red spectra the subject has become the best method for obtaining information on the structure of molecules and their energy levels. Certain symmetry motions of the atomic centres are inactive in the infra-

red spectrum and only from the Raman spectrum can these vibrations be observed. The use of infra-red spectra as a means of analysis has replaced many normal chemical methods. The growing importance of infra-red and Raman spectroscopy in industry is evidenced by the increasing number of industrial laboratories which employ this as a tool to further their research programmes. Large numbers of infrared spectrometers are used in the chemical industrial firms. One chemical firm in U.S. has over 100 infra-red spectrometers throughout its operation. Infra-red analysis is used extensively in the petroleum industry and in organic chemical plants.

FAR INFRA-RED SPECTRA

The Raman spectroscopy, because of its greater technical facility, has contributed more than infra-red absorption spectrometry to molecular spectra studies in the far infra-red. The Raman Spectra were the only means of measuring low lying vibrations (25 to 400 cm^{-1}) of bands until a few years ago. Now there are available infra-red spectrometers which will measure spectrum in this region. By the use of prisms of $CsBr$ and CsI infra-red spectra can be measured as low as 56μ (190 cm^{-1}) and with grating instrument the spectra can be measured to 400μ (25 cm^{-1}). The spectrometers with $CsBr$ and CsI prisms are only slightly different from the conventional $NaCl$ instrument. However, there is the greater problem of removing stray radiation. With the small grating instruments for the far infra-red the higher orders of the grating must be removed. This is usually accomplished by the use of reflection filters. The reflection filters may be restrahlen plates or roughened mirrors. Black polyethylene has been found to be an excellent transmission filter. The Golay cell is a very good detector for the far infra-red and a high pressure mercury arc in quartz makes a good source.

In the far infra-red spectrum there are three types of researches which are being carried out. They are (1) the measurement of crystal spectra; (2) pure rotation spectra, and (3) vibration and torsional bands. On account of the high level of activity in researches of the solid state there is a considerable demand for measurement in the far infra-red. In these measurements it is usually desirable to study the spectrum at different temperatures. In some cases temperatures as low as those of liquid helium and liquid hydrogen are used. Marked changes of great significance are observed in the spectrum at such low temperatures.

At present considerable interest is shown in the findings of the torsional vibrations in compounds such as substituted ethane (for example CHBr_2 , CH_2Br). These bands usually fall between 100 and 300 cm^{-1} and are easily observed with a small grating spectrometer.

CONCLUSION

In conclusion it appears that Raman and infra-red spectra are the two most important tools

for the study of molecular spectra. With pre-
sent-day resolution information may be obtained by the spectra of heavy molecules which was previously thought impossible. Also, the importance of infra-red spectra in astrophysics is now beginning to be recognised. Present indications are that infra-red researches will be important and will be in high activity for many years.

INDIAN ACADEMY OF SCIENCES : XXVI ANNUAL MEETING

THE Twenty-Sixth Annual Meeting of the Indian Academy of Sciences was held in Madras on 27, 28 and 29 December 1960, at the invitation of the Madras University. The inaugural function was held in the Senate Hall of the University before a large gathering of distinguished Guests, Fellows and Delegates. Sir A. Lakshmanaswamy Mudaliar, Vice-Chancellor of the University, in his Inaugural Address spoke on the impact of fundamental sciences on applied science. The days are long past, he said, when the different disciplines in science were treated as isolated and unconnected units and the more one sees of the progress of science in general, the more is one convinced that all scientific work is interdependent, that there can be no question of science being looked upon in separate compartments. Science in its broadest sense is one and indivisible. In this connection Sir Lakshmanaswamy referred to his own profession—medicine—which owed its greatest progress during the last half a century to the knowledge gained by the great discoveries in many fields of fundamental sciences like physics, chemistry, zoology and botany. He concluded by saying that the artificial distinction sought to be made between fundamental and applied science is unreal and will not lead to progress. A happy blending of both aspects has so far given us results which encourage us in the hope that more and more benefits of science will accrue to humanity at large.

Sir C. V. Raman, President of the Indian Academy of Sciences, in his Presidential Address on the "Physiology of Vision" described in detail the methods and results of the simple but extremely powerful technique which he has invented and which enables one to see the retina of his own eyes in the act of functioning. The observer sits facing a brightly lit white screen and views it through an appropriate colour filter held in front of his eye. After a sufficient interval of time, he fixes his vision on some

particular point on the screen and then removes the filter. An enormously magnified picture of the retina then appears on the screen, the nature of which depends very much on the particular colour filter used. The explanation of the phenomenon is that the rays of the spectrum which in the first instance are absorbed by the filter, suddenly impinge on the retina when the filter is removed, and excite localised sensations over its different areas. These sensations project themselves on the observing screen as an enlarged image of the retina.

By correlating the absorption spectra of the filters used with the pictures of the retina perceived by the observer, it has been ascertained that the retina contains three visual pigments whose absorption spectra lie in different regions of the spectrum. The three pigments have been identified as (1) Xanthophyll which absorbs light in the blue and violet sectors of the spectrum; (2) Ferroheme which exhibits a powerful absorption in the green sector located at the same position as the maximum of visual luminosity in the spectrum and (3) Ferriheme whose absorption is weaker than that of ferroheme, but extends much further towards longer wavelengths and sensible up to the extreme red end of the spectrum.

Sir C. V. Raman then proceeded to show how it is possible to connect the observed variations of luminosity and colour in the spectrum with the absorption characteristics of the visual pigments. On the basis of the new theory proposed a natural and satisfactory explanation could be given for chromatic and achromatic sensations and also for defective colour vision. Chromatic sensations arise when only two of the three visual pigments function, and achromatic sensation arises when all the three visual pigments function in appropriate strengths. The existence of both ferroheme and ferriheme as visual pigments in the retina presupposes that there is a biochemical mechanism which determines the proportions in which they are normally

present. Any deviations of the mechanism from normality would produce an imbalance in the ferroheme—ferriheme ratio in the retina which will account for the various types of defects in colour vision.

The second and third days of the session were devoted to scientific meetings in Section A (Physical Sciences) and Section B (Biological Sciences). Dr. S. Bhagavantam was the Chairman for meetings in Section A, and Dr. K. Ramiah was the Chairman for Section B.

In Section A, there was a Symposium on "Vibration Spectra of Molecules and Crystals" in which there were three invited one-hour talks. The first talk was given by Dr. S. Bhagavantam on "Molecular Vibrations in Theory and Experiment". The second talk was by Dr. Earle K. Plyler on "Recent Advances in Infra-Red Spectroscopy" (see p. 1). The third talk was by Sir C. V. Raman on "The Vibration Spectra of Crystals in Theory and Experiment".

In the scientific meetings in Section A, the following half-hour papers were presented (1) "The Structure of Collagen" by Prof. G. N. Ramachandran; (2) "Masses of Elementary Particles" by Dr. Alladi Ramakrishnan; (3) "Coherence Properties of Light" by Dr. S. Pancharatnam; (4) "Molecular Structure" by Dr. K. S. Viswanathan; (5) "Electro-deposition" by Dr. K. S. G. Doss; (6) "The Crystal Structure of Echitamine" by Dr. S. Ramaseshan (see p. 5); (7) "Raman Effect Studies" by Dr. K. Venka-

teswarlu; and (8) "Mechanism of Chemical Reactions in Solution" by Prof. S. V. Ananthakrishnan.

In the scientific meeting in Section B, the following half-hour papers were presented; (1) "The Genetics of Rice" by Dr. K. Ramiah; (2) "Photosynthesis" by Prof. T. S. Sadasivan; (3) "Structure and Synthesis of Tylophorine" by Prof. T. R. Govindachari; (4) "Biochemical Research with Corcyra" by Prof. P. S. Sarma; (5) "Cellulose Formation by Micro-organism" by Dr. K. Ramamurti; and (6) "Leptocephali in Indian Waters" by Sri. R. Velappan Nair.

There were two public lectures in the evening of the 28th and 29th. The first lecture was on "The Story of the Earth" by Dr. S. Bhagavantam and the second was on "Music and Musical Instruments" by Sir C. V. Raman.

On the 30th December there was an excursion to Mahabalipuram famous for its monolithic architecture and rock carvings of the 7th century A.D.

At the business meeting of the Academy held on December 27, the following were elected to the Academy: *Honorary Fellows*: Professor Theodore Von Karman, France; Professor San-Ichiro Mizushima, Japan; Professor Axel Hugo Teodor Theorell, Sweden.

Fellows: Dr. Jacob Chandy, Dr. V. S. Huzurbazar, Dr. T. N. Khoshoo, Dr. S. Krishnaswamy, Shri K. Nagabhushana Rao, Dr. M. Santappa, Dr. A. P. Subramaniam.

INDIAN SCIENCE CONGRESS

THE Forty-Eighth Session of the Indian Science Congress was held in Roorkee from January 3-9, 1961. Dr. Rajendra Prasad, President of India, inaugurated the session. In his Inaugural Address Dr. Rajendra Prasad expressed the hope that science would continue to serve mankind and that the new knowledge man has acquired will be used for the conquest of want and eradication of human suffering. Stressing on the importance of spiritual values Dr. Rajendra Prasad said that it had become increasingly clear that the only way to harness the discoveries of science into the service of man was by developing a sense of values, call it moral or religious or spiritual. Without it, all the advance and the consequent material progress, howsoever good in itself, would ever continue to hold before mankind the threat of extermination.

Dr. N. R. Dhar, General President of the Session, in his Presidential Address on "Nitrogen Problem" dealt with the subject of soil fertility from the point of view of the application of

nitrogenous fertilizers to the land. Dr. Dhar claimed that "industrial nitrogen is unable to cope with world food production but organic matter aided by calcium phosphates and light can meet the situation and improve land fertility permanently".

The papers presented at the different sections were read and discussed in the sectional meetings presided over by their respective Presidents. The thirteen sections and their Presidents were as follows: 1. Mathematics (Dr. R. S. Varma), 2. Statistics (Dr. G. R. Seth), 3. Physics (Dr. S. R. Khastgir), 4. Chemistry (Dr. T. N. Ghosh), 5. Geology and Geography (Shri W. B. Metre), 6. Botany (Dr. P. N. Mehra), 7. Zoology and Entomology (Dr. S. P. Ray Chaudhuri), 8. Anthropology and Archaeology (Dr. P. C. Biswas), 9. Medical and Veterinary Sciences (Dr. A. K. Hazra), 10. Agriculture (Dr. B. L. Chona), 11. Physiology (Dr. D. N. Mullick), 12. Psychology and Education (Dr. N. Mukherji), and 13. Engineering (Dr. H. N. Das Gupta).

THE STRUCTURE OF ECHITAMINE IODIDE

H. MANOHAR AND S. RAMASESHAN

From the Department of Physics, Indian Institute of Science, Bangalore-12

ECHITAMINE ($C_{22}H_{28}O_4N_2$) the major alkaloid derived from the bark of *Alstonia scholaris*, has been attracting the attention of the organic chemist in recent months and its structure has been the subject of some controversy.¹⁻⁶ The determination of its X-ray, crystal structure was undertaken by the present writers at the instance of Prof. T. R. Govindachari who was kind enough to prepare for them the quaternary iodide and the chloride ($C_{22}H_{28}O_4N_2I$, Cl). Goodson and Henry⁷ report that the iodide crystallises in the anhydrous state while the chloride crystallises as "stumpy prisms" with one molecule of water when crystallised slowly from water but as long anhydrous needles when crystallised rapidly. Chemical analysis of the iodide by Prof. Govindachari gave the formula $C_{22}H_{28}O_4N_2I$. No analysis was done on the chloride but the needle shape of the crystals was taken to indicate the absence of any water of crystallisation.

Rotation and Weissenberg photographs gave the space group to be $P2_12_12_1$ with the following axial dimensions in Ångstrom units:

	<i>a</i>	<i>b</i>	<i>c</i>
Echitamine iodide	.. 18.45	13.83	8.48
Echitamine chloride	.. 17.29	14.97	7.94

The measured value of the density in the case of the iodide ($d = 1.583$) gave four molecules in the unit cell and confirmed the anhydrous nature of the crystals. The density of the chloride was not determined. The differences in the axial dimensions suggest that the isomorphism between the two compounds may not be exact.

Intensity data were collected for the hko , hkL ($L = 1$ to 5) and hol reflexions using the multiple film technique of Robertson and the intensities were accurately measured visually using calibrated scales. In the hko zone there were 196 reflexions of measurable intensity for the iodide and 166 for the chloride. The L.P. and absorption corrections were applied and the approximate scale factors determined by the Wilson method.

An hko Patterson projection gave the iodine position to be $x = 0.067$, $y = 0.190$ in fractional co-ordinates. By the heavy atom and the isomorphous replacement method the phases of 70 reflexions for the iodide and 52 reflexions for the chloride could be deduced with some certainty. However, it was decided to proceed only with the solution of structure of the iodide. A Fourier projection using these 70 amplitudes not only confirmed the iodine position but also showed a large number of other peaks. From the structure factor computation made on putting 17 carbon atoms at the peaks in the Fourier, 66 additional signs could be assigned. A Fourier with these terms included showed better resolution, a phenyl and a five-membered ring being easily distinguishable. The iterative process of Fourier synthesis was continued till all the 28 atoms of the molecule (excluding the hydrogens) could be put in at the Fourier peaks. The structure factor calculations with all the atoms assumed to have the scattering factor of carbon gave the signs of about 169 reflexions and the R factor was 0.28.

A subtraction Fourier projection with the temperature corrected iodine contribution removed showed very much better resolution and with the movement of the atoms to the peaks the R-factor came down to 0.22. A Difference-error synthesis indicated that six atoms had been placed in wrong positions. On moving them to high positive regions not only did the R-factor come down to 0.19, but most of the "bad" reflexions became very much better. This was followed by two subtraction Fouriers and one difference projection and the subsequent structure factor calculation gave the phases of 192 out of 196 observable reflexions. Of the 23 reflexions whose phases were obtained in the later stages of the iterative process there were a few of medium intensity (e.g., $210 : F_0 = +21.5$, $F^1_{\text{obs}} = -35$) whose signs came out opposite to those deduced by the heavy atom method. These had a considerable effect in not only resolving the peaks in the iodine removed Fourier but also in completely suppressing many spurious peaks.

The iodine removed hko Fourier projection is given in Fig. 1. A very small peak persists at the iodine position but each one of the 28

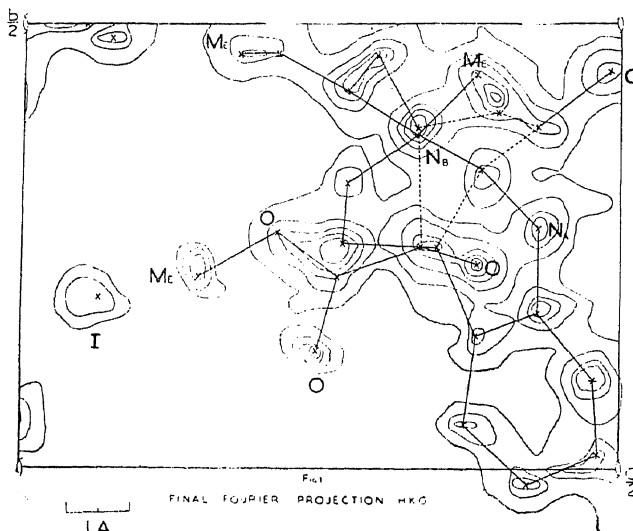


FIG. 1

heavier atoms of the molecule could be easily identified. The structure factor calculation gave an R-factor of 0.15 for 196 observed $h\bar{k}\bar{o}$ reflexions. The unobserved reflexions also calculated quite low.

The configuration of any molecule can be assigned without ambiguity only if its crystal structure has been solved in at least two projections. However as the iodine subtracted $h\bar{k}\bar{o}$ projection (Fig. 1) shows very good resolution it should be possible to deduce the molecular structure from it making use of some of the well-established chemical data about the compound.

It became increasingly clear during the progress of this work that the structure (I) sug-

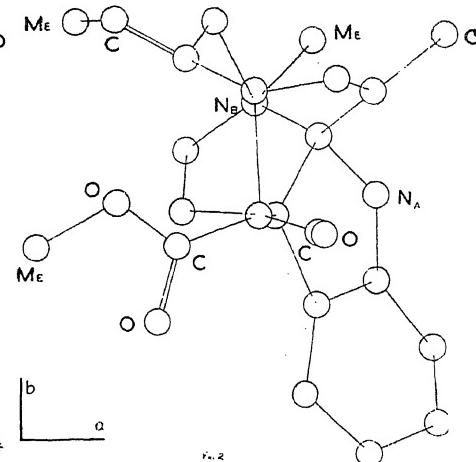
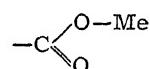


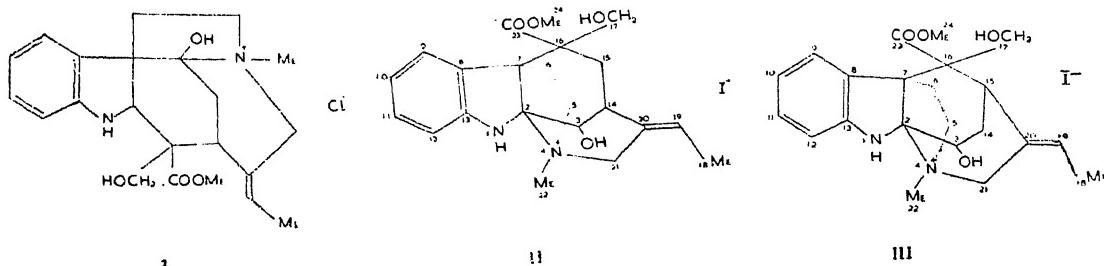
FIG. 2

shaped ring (dotted lines in Fig. 1)—along a common bond; (3) the carbomethoxy group



is attached to the six-membered boat at the equatorial position; (4) the heavy peak at the centre of the first five-membered ring is due to two atoms and is therefore presumably the carbon and the oxygen of the CH_2OH . This group is attached to the same carbon atom of the boat as the carbomethoxy group; (5) an oxygen atom (probably the OH group) is attached to the opposite point of the boat.

The $=\text{C}-\text{Me}$ can also be identified although



gested by Conroy⁴ or its modification due to Robinson *et al.*⁵ are incompatible with the Fourier projection. In the $h\bar{k}\bar{o}$ projection (Fig. 1) the following features may be clearly discerned: (1) A phenyl ring with a five-membered ring fused to it; (2) this five-membered ring is fused on to two other rings—one five-membered and one six-membered boat-

the manner in which it is joined to the main structure is not so clear. For deducing this a model given by II which satisfies all the five points mentioned above was first tried. The model appeared to have the further merit in having (a) the $\phi-\text{N}-\text{C}-\text{N}$ system advocated by Govindachari¹ and Birch⁶; (b) the same number of five-membered and six-membered

rings as in the structure due to Conroy and Robinson *et al.* When the three-dimensional model was made it was found that it could explain all but two of the peaks in the Fourier projection.*

However, when the bond connecting C₂₀ to C₁₄ was shifted to C₂₀—C₁₅ as in III (making the lower six-membered ring of II into a seven-membered ring), all the atomic peaks could be most satisfactorily explained. It appears therefore that III is the most probable structure of echitamine iodide. Figure 2 gives the identification of the Fourier peaks in Fig. 1, according to the structure III. The solution of the *hol* projection and the refinement of the parameters are in progress.

The authors wish to record their grateful thanks to Prof. T. R. Govindachari of the Presidency College, Madras, for preparing the compounds and for the invaluable discussions they had with him. Thanks are due to Prof. D. K. Banerjee and Mr. G. Bagavant of the Indian Institute of Science with whom the authors were in constant consultation. Thanks are also due to Prof. R. S. Krishnan for his very kind interest in this problem.

* At this stage Prof. T. R. Govindachari intimated one of us (S.R.) that he had received a letter from Prof. J. Monteath Robertson stating that he had solved the structure of echitamine bromide and that it corresponded to III. Model III was tried only after the receipt of this information.

1. Govindachari, T. R. and Rajappa, S., *Proc. Chem. Soc.*, 1959, 134; *Chem. and Ind.*, 1959, 1154 and 1549.
2. Birch, A. J., Hodson, H. F. and Smith, G. F., *Proc. Chem. Soc.*, 1959, 224.
3. Chatterjee, A., Ghosal, S. and Majumdar, S. G., *Chem. and Ind.*, 1960, 265.
4. Conroy, H., Bernasconi, R., Brook, P. R., Ikan, R., Kurtz, R. and Robinson, K. W., *Tetrahedron Letters*, 1960, No. 6, 1.
5. Chakravarthi, D., Chakravarthi, R. N., Ghose, R. and Sir Robert Robinson, *Ibid.*, 1960, No. 10, 10; No. 11, 25; No. 12, 33.
6. Birch, A. J., Hodson, H. F., Moore, B., Potts, H. and Smith, G. F., *Ibid.*, 1960, No. 19, 36.
7. Goodson, J. A. and Henry, T. A., *Jour. Chem. Soc.*, 1925, 127, 1640.
Goodson, J. A., *Ibid.*, 1932 (2), 2626.

Note added in Proof: Prof. J. M. Robertson has kindly informed us that the compound used by him for solving the structure was ecnitamine bromide with a molecule of methanol as solvate.

VARENNA SUMMER SCHOOL ON RADIOFREQUENCY SPECTROSCOPY

C. R. KANEKAR AND B. VENKATARAMAN

Atomic Energy Establishment, Trombay, Bombay

THE "Enrico Fermi" International School of Physics sponsored by the Italian Physical Society, under the joint auspices of the Italian Ministry of Public Instruction and the Italian National Council of Research, held its Seventeenth International Summer School Course entitled "Topics on Radiofrequency Spectroscopy" at the Villa Monastero, Varenna, on Lake Como from 1st August to 17th August 1960. Professor A. Gozzini (Pisa) was the Director of this Course.

The subjects discussed in the School can be broadly classified under the following headings: (1) Radiofrequency spectroscopy of optically oriented atoms; (2) Study of nuclear and atomic ground states by atomic beams; (3) Masers and maser spectroscopy; (4) Double irradiation in magnetic resonance. The lectures were delivered in French and in English.

The Course commenced with a general exposition by Professor Brossel (Paris) on optical pumping. The subject of optical methods in magnetic resonance was discussed in a series

of twelve lectures by Professor A. Kastler, Professor J. Brossel, Dr. C. Cohen-Tannoudji and Dr. A. D. May (all from Ecole Normale Supérieure, Paris) and Professor T. Skalinski (Warsaw). The aspects of optical pumping which covered these lectures were (*i*) the experimental methods for optical pumping and the detection of nuclear magnetic resonance; (*ii*) a theoretical discussion of the phenomenon of coherence in optical resonance study of the fundamental states and optically excited states of atoms; (*iii*) measurement of lifetimes of excited states; (*iv*) study of collisions; and (*v*) investigations of excited states produced by electronic bombardment.

Professor W. A. Nierenberg (Berkeley) dealt with the study of atomic and nuclear ground states by atomic beams. After a heuristic discussion of the hyperfine Hamiltonian, the Breit-Rabi diagram and the atomic magnetic moment, he described the computational methods for determining the parameters *a*, *b*, *g*, and *g*₁. The results so far obtained on Pu²³⁹, Pu²³², Tm¹⁷⁰ and Pa²³³ were presented.

Professor C. H. Townes (Columbia), Professor K. Shimoda (Tokyo), Professor B. Elschner (Jena) and Dr. Ali Javan (Bell Labs.) conducted the lectures on Masers and Maser Spectroscopy. The noise figures of maser amplifiers, the limits on electromagnetic amplification due to complementarity and the phase and frequency fluctuations in a maser oscillator were discussed by Townes. A travelling wave solid state maser developed by Bell Telephone Laboratories was described. The application of masers to generation, amplification and detection of very high frequencies in the optical and infra-red region were discussed and a report on the recently developed infra-red and optical masers was given. The lectures delivered by Professor Shimoda covered the following aspects of beam maser spectroscopy : (1) a discussion of the sensitivity and line-width in both conventional and beam maser spectroscopy in the microwave region ; (2) the experimental results that have been obtained using maser spectrometers on (a) the magnetic hyperfine structure and the Zeeman effect of the ammonia spectrum, (b) the low frequency rotational spectra of formaldehyde at 4.5769 Mc./s. ; (3) three-level maser spectroscopy of gases with OCS and HDCO as examples and (4) the applications of the three-level maser for ultramicrowave spectroscopy.

Professor B. Elschner's exposition on solid state masers dealt with Bloembergan's theory of the three-level maser action of a crystal with paramagnetic ion ; Javan's theory of three-level masers ; applications of these theories to ruby masers ; a two-level maser attained by adiabatic fast passage and the experimental results obtained on a Raman-type maser.

Dr. Javan described his attempts at the Bell Telephone Laboratories to attain negative temperature in atoms by electron impact.

Professor A. Abragam's (Saclay) exposition consisted of a general formalism for the explanation of double irradiation effects in magnetic resonance. The formalism employs spin density matrices and takes into account the interactions that lead to the phenomena observed. Equations were developed for (1) interaction between electronic and nuclear spins ; (2) calculation of line-widths ; (3) spin diffusion ; (4) Overhauser effect in liquids, metals and semiconductors ; (5) experiments at elevated and very feeble magnetic fields ; (6) relaxation mechanisms and measurements of earth's fields ; (7) the solid effect ; (8) electronic and nuclear double resonance (ENDOR). Dr. J. Winter (Saclay) gave a theoretical description for multiple quantum resonance absorption. One of the most interesting results reported by the Saclay School was the observation of nuclear resonance of Co⁵⁹ and Fe⁵⁷ in ferromagnetic substances with no external magnetic fields. The resonance absorption arises from the levels split by the local fields of the order of 100,000 gauss, whose intensity could be arrived at from the Mössbauer effect. The surprisingly large intensity of absorption in Fe⁵⁷ has been explained in terms of the Bloch walls being modulated by the applied r.f., thereby augmenting the intensity of the r.f. field at the site of the nucleus.

Among the other subjects discussed in the School were electric dipolar transitions of two quanta in a gas by A. DiGiacomo (Pisa) and the applications of radiofrequency spectroscopy to frequency and time standards by J. De Prins (Neuchatel).

CULTIVATION OF ALGAE IN HEAVY WATER

A N exhibit demonstrating the cultivation of green algae in heavy water was shown by Argonne National Laboratory, Argonne, Ill., at the Seventh International Soil Science Congress at the University of Wisconsin.

This exhibit demonstrated, for the first time, how algae can grow in an environment where nearly all of the atoms of hydrogen have been replaced by atoms of the rare isotope deuterium.

The exhibit consisted of a transparent plastic container 24 in. in diameter with a rotating paddle-wheel agitator. Nutrient, light, and a

mixture of 5% carbon dioxide and 95% nitrogen gas were provided. The algae were kept cooled to room temperature.

Algae grown in heavy water synthesize organic compounds containing only deuterium in positions normally occupied by hydrogen. The deuterated compounds, for example, glucose, can then be fed to other plants and animals in research to determine the effects of heavy hydrogen on metabolism. The preparation of many of these synthetic compounds by other laboratory methods is difficult, often impossible,

LETTERS TO THE EDITOR

DIURNAL VARIATION OF F_1 REGION DRIFTS AT WALTAIR

HORIZONTAL drifts in E and F_2 regions of the ionosphere at different latitudes have been studied by several investigators. Except for a few observations taken at Mayaguez by Donald Yerg¹ and at Cambridge, Mass., by Kurt Toman,² the F_1 region drift measurements have not been reported so far from any other station. In a recent communication³ the authors reported results of F_1 drift measurements taken at Waltair at 0900, 1200 and 1500 hours. The present communication contains the results of F_1 region diurnal study carried out for all the four seasons of the year, during the period of 1956-58, at Waltair, using the spaced receiver method of Mitra.⁴

The operating frequency for each observation was decided taking into account the critical frequencies of E and F_1 regions. On some days during the early morning and late evening hours the f_0E and f_0F_1 values were so close that it was not possible to get reflections from F_1 region alone, without partial reflections from E region. For this reason F_1 drift measurement could not be taken for all the twelve hours during the interval 0600 to 1800 hours I.S.T. in all the four seasons. In summer the occurrence of E_s presented some difficulties reducing the volume of diurnal data. In view of these, the operating frequency had to be different on different days and generally lay between 4.0 Mc./sec. and 4.8 Mc./sec. The virtual height of F_1 reflection varies between 230 and 260 Km. In order to minimise the effect of lower region on the pulses reflected from the F_1 region, care was taken to see that the operating frequency for F_1 region was sufficiently higher than the critical frequency of E region.

Considering first the variation of drift speed, it is observed that there is no significant change in the magnitude of F_1 drift from hour to hour except that at noon time the drift speed may be said to be a little higher than at other hours.

The curve depicting the diurnal variation of F_1 drift direction for the four seasons is shown in Fig. 1. The drift direction in degrees East of North is plotted against the time at which the observation was taken. It is interesting to note that in winter the F_1 drift was directed towards SW throughout the duration of 0800

to 1600 hours when observations were possible. In all the other seasons the drift direction was towards NE in the morning and evening hours. It can also be seen that the times at which the drift direction changes from NE to SW in the morning and SW to NE in the evening as well

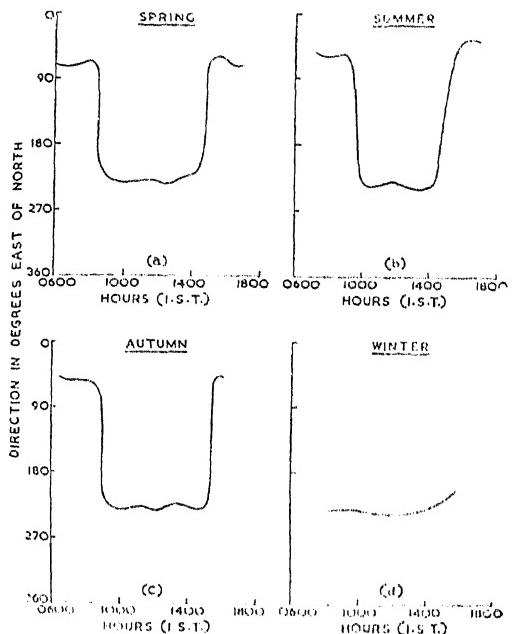


FIG. 1

as the duration for which the drift was directed towards SW shows definite seasonal variations. For instance in Summer the drift changes from NE to SW after 0930 hours and changes back to NE by about 1500 hours, the duration for which it was directed towards SW being about four hours which is the shortest compared to the duration of eight hours or more for Spring and Autumn. Even though the duration, for which F_1 drift was directed towards SW, was nearly the same for the Spring and Autumn seasons the transition time from NE to SW in the morning and SW to NE in the evening occurs about half an hour later in the Autumn compared to the Spring season. The drift directions observed at 0900, 1200 and 1500 hours from this diurnal study are in general agreement with the directions reported by the authors³ from an analysis of records taken at 0900, 1200

and 1500 hours. Thus it may be seen that in all seasons except winter the F_1 drift direction shows a systematic variation.

For all the four seasons the EW and NS components are plotted separately with a view to see if there is any phase difference between the two components. It was found that the variation of the EW and NS components is similar both in magnitude and direction except in Summer when they showed a small phase difference. Thus it seems that at this low latitude station there is no systematic clockwise rotation of drift vector from hour to hour. On the other hand the drift vector shows a rapid reversal of direction twice in a period of 12 hours. From an analysis of about 26 observations Donald Yerg¹ found that at Mayaguez the mean drift for the F_1 region was towards NW in the morning and changes to NE by late afternoon, through North. Thus the F_1 drift direction at noon for Mayaguez is opposite to the direction obtained by the authors for Waltair, though the directions in the morning and late evening hours may be said to be in general agreement with the present results.

The authors are indebted to the Council of Scientific and Industrial Research (India) for financial support of these investigations.

Ionosphere Laboratories, E. BHAGIRATHA RAO.
Andhra University, B. RAMACHANDRA RAO.
Waltair (India),
November 20, 1960.

1. Verg, D. G., *J. Geophys. Res.*, 1955, **60**, 173.
2. Toman, K., *Ibid.*, 1955, **60**, 57.
3. Rao, B. R. and Rao, E. B., *J. Atmosph. Terr. Phys.*, 1959, **14**, 94.
4. Mitra, S. N., *Proc. Instn. Elect. Engrs.*, 1949, **96**, Part III, 441.

PAPER CHROMATOGRAPHIC METHODS OF SEPARATION OF COPPER, NICKEL AND COBALT FROM ONE ANOTHER AND THEIR DETECTION

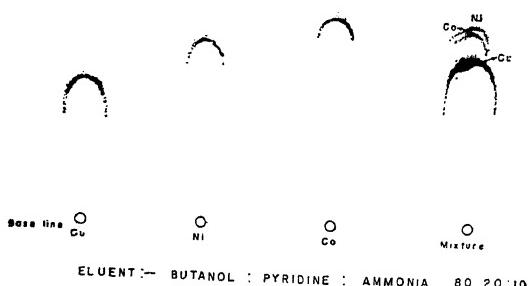
POLLARD AND McOMIE,¹ while discussing the chromatography of inorganic ions, drew attention to the solubility of several metallic thiocyanates in organic solvents and suggested that this fact should merit further examination for use in chromatography. In a preliminary paper, Martin² reported that several metallic ions when treated with thiocyanic acid in butanol and eluted on a filter-paper according to Rutter's technique, have R_f values, which differ markedly from ion to ion and this could easily form the basis of separation of these ions from their mixture.

In the separation of metallic ions on paper, several factors are operative, viz., (1) complexation nature of the ion; (2) nature of eluents; (3) pH and (4) treatment of paper. For an effective separation, each of these factors has to be separately considered.

Bock³ made an extensive study of the influence of concentration of the thiocyanate on the distribution of metallic ions between water and organic solvents. Some of the metallic ions, e.g., of molybdenum and tungsten give thiocyanates extractable by organic solvents only in their lower state of valency.⁴ Some other ions become soluble when their mercuric-thiocyanates are obtained.⁵ Precipitates of certain thiocyanates become soluble in organic solvents on addition of pyridine.⁶ A number of possibilities thus present themselves for affecting the separation amongst themselves of ions by taking advantage of the possibilities offered by the above-mentioned complexing procedures which may selectively be employed. The role of eluents in the separation of inorganic ions has been extensively discussed by Lederer and Lederer⁷ in their book and in an exhaustive summary, possibilities of two-dimensional chromatography using groups of solvents has also been discussed.

In the following paper is described the method of separation of some ions using thiocyanates and some selected eluents.

The ions studied were iron, uranium (VI), copper (ic), nickel and cobalt. The thiocyanates of Fe and U precipitate in an alkaline medium in presence of pyridine, while those of Cu, Ni and cobalt are soluble in the same. Study of the last three ions was made in the first instance.



Solutions

FIG. 1

- (1) Copper solution—M/100 and M/500
- (2) Nickel solution—M/100 and M/500
- (3) Cobalt solution M/50

In each case the required quantity of salt, generally the sulphate, was dissolved in water,

and if necessary, a small quantity of the acid was added.

- (4) Potassium thiocyanate—40% in water
- (5) Pyridine (AnalR)
- (6) Ammonia, CP (0.88)
- (7) Butyl alcohol (CP)
- (8) Amyl alcohol (CP).

One drop each of the solution of the above salts was placed about 2 inches apart on the base line of Whatman filter-paper No. 1. The volume of liquid transferred was about 0.005 ml. from a micro-pipette. When the metal ion spots had dried, about 0.01 ml. of the thiocyanate solution was transferred to each of these, paper-dried, rolled in the form of a cylinder and placed in the trough containing the desired eluent and then covered immediately with a bell-jar. All the usual precautions were taken. The spots were allowed to develop for 2-3 hours. At the end of the period, the paper was taken out, dried and the ions detected suitably. Reasonably compact spots were obtained with the following eluents.

- (1) Butanol : Pyridine : Ammonia
(80 : 20 : 10).
- (2) n-Amyl alcohol : Pyridine : Ammonia
(80 : 20 : 10).

Detection of the ions could best be done as under :

Cobalt.—On exposure to acetone, a blue spot immediately appeared which faded on standing. The position and outline of cobalt was therefore marked with a pencil.

Nickel.—On spraying with 1% alcoholic solution of dimethyl glyoxime, a permanent red spot developed.

Copper.—On spraying with 1% alcoholic solution of rubeanic acid, a slate-grey spot was developed which was also permanent.

The position of the spots in ascending order is copper : cobalt : nickel. The latter two are fairly near to one another and may even overlap.

For the spots to be compact it is necessary to have thiocyanate at least 100 times more than that required to form a complex with the metallic ion.

The technique discussed above may be employed for detecting Cu, Co and Ni when present together in a mixture. After elution with either of the above eluents, the paper is first exposed to acetone. The cobalt, if present, occurs half-way from the liquid front. After marking the spot for cobalt with pencil, the same area is sprayed with dimethylglyoxime. To detect copper, solution of rubeanic acid is sprayed at a distance nearly 2/5 of the distance

to which the liquid front has travelled from the base line. A typical separation obtained from 3γ of Cu, 3γ of Ni and 6γ of Co is reproduced here in the chromatogram. Smallest quantities that can be easily detected are : Cu : 0.6γ, Ni : 0.6γ and Co : 6γ.

National Physical Laboratory, M. R. VERMA.
Hillside Road, P. K. GUPTA.
New Delhi, December 5, 1960.

1. Pollard, F. H. and Mc Omie, J. F. W., *Chromatographic Methods of Inorganic Analysis*, Butterworths Scientific Publications, London, 1953, p.60.
2. Martin, E. C., *Analyst. chim. Acta*, 1951, 5, 511.
3. Bock, R., *Z. Anal. Chem.*, 1951, **133**, 110.
4. Crouthamel, C. E. and Johnson, C. E., *Analyst. Chem.*, 1954, **26**, 1284.
5. Seidell, A. and Linke, *Solubilities of Inorganic and Metal Organic Compounds*, D. Van Nostrand Co., 1958, pp. 797, 1202.
6. Sandell, E. B., *Colorimetric Determination of Traces of Metals*, Interscience Publishers Inc., New York, 1950, p 131.
7. Lederer, E. and Lederer, M., *Chromatography*, Elsevier, Amsterdam, 1957, p. 477, et. seq.

PERSPEX ELECTRETS

ELECTRETS¹ are electrostatic magnets which have many properties similar to magnets but each electret has its own peculiarities. Many substances have been tried for their preparation, but very little work seems to have been done on plastic electrets. Considering the varieties of uses of plastics because of their many important properties, it was thought worth while to attempt the preparation of plastic electrets and study their behaviour. A preliminary report of this work is given in this paper.

Perspex (polymethyl methacrylate) supplied by ICI was tried for this purpose. Electrets were prepared at various temperatures between 120° C. and 160° C. (near the softening point 140° C.) and with different polarising fields (8 to 20 kv./cm.) and their charge decay curves were studied. Here the polarising time was kept constant at 12 hours.

The surface of the electret which was in contact with the positive electrode is referred here as positive surface and the other negative. The surface charge of electrets are referred as homo- and hetero-charges after Gement.² The homo-charge is that which shows the same polarity as the forming electrode while the hetero-charge is that which shows opposite polarity. The homo-charge is attributed³ to the conduction currents across the dielectric-electrode interface, and the hetero-charge is due to the polarisation of ions on the surface of the dielectric.

The results of study may be summarised as follows :—

1. The decay charge curves on the positive surface has the same shape and properties, as observed in the case of carnauba wax electrets.^{1,3,4} The initial charge is hetero for temperatures 150° C., 160° C. and above, while it is only homo-charge for temperatures 140° C., 130° C. and below ; irrespective of the polarising voltage.

2. The final charge in all the cases is a homo-charge and it is found to depend on the polarising temperature and also on the field. The maximum charge is 2.1 e.s.u. (temp. 130° C., field 13.33 kv./cm.).

3. At lower temperature, 140° C., the initial charge is found to increase with the increase in polarising field, but at higher temperatures, this is not very regular.

4. Up to the temperature 140° C. the initial charge is only homo- and after this temperature (above 140° C.) we get both the hetero- and homo-charge, with the usual charge reversal from hetero- to homo-charge, after some days.¹

The temperature of this charge reversal is found to depend on the area (total energy) of the so-called "Hysteresis"⁵ curve, drawn between forming field and current.⁶ It is found in the case of perspex that the area of these curves goes on decreasing as the temperature is increased, showing a minimum in area at 140° C. and thereafter the area increases. The existence of the homo-charge and hetero-charge along with their curve characteristics is in agreement with Gross's theory and may be explained on the same basis.³

The charge on the negative surface is not equal and opposite to that on the positive surface.⁴

The author is thankful to Prof. D. R. Bhawalkar and Dr. J. D. Ranade for their interest in the work and to the Ministry of Scientific Research and Cultural Affairs for the award of a Research Fellowship.

Department of Physics, C. S. BHATNAGAR.
M.A. College of Technology,
Bhopal (M.P.),
August 30, 1960.

1. Gutmann, F., *Rev. Mod. Phys.*, 1948, **20**, 457.
2. Gement, A., *Phil. Mag.*, 1935, **20**, 929.
3. Gross, B., *Phys. Rev.*, 1944, **66**, 26.
4. Bhatnagar, C. S., *Jour. Sci. and Industr. Res.*, 1960, **19B** (8), 277.
5. —, *Proc. Ind. Acad. Sci.*, 1952, **36**, 170.
6. Shrivastava, A. P. (Unpublished).

IODOMETRIC AMPEROMETRIC DETERMINATION OF COPPER (II)

COPPER (II) oxidizes iodides with formation of low solubility cuprous iodide : $2 \text{Cu}^{2+} + 5 \text{I}^- \rightarrow 2 \text{CuI} \downarrow + \text{I}_3^-$. The iodine liberated is titrated between pH 3.2 to 5.2 with standard thiosulphate solution titrimetrically using starch indicator, or electrometrically.¹⁻⁵ The electrometric methods are of distinct advantage in the titration of very dilute solutions. Pring and Spencer,³ using the dead stop end-point as described by Foulk and Bawden,² obtained good results with solution as dilute as 0.004 N. In the present investigations, iodometric amperometric estimations of copper (II) at constant voltage with two polarized electrodes have been carried out with success at higher dilutions.

The substances involved in the titration are soluble. The couple, $\text{I}^- - \text{I}_3^-$ is reversible and $\text{S}_2\text{O}_3^{2-} - \text{S}_4\text{O}_6^{2-}$ is irreversible. The current-potential curves of the system : $\text{I}_3^- + 2 \text{S}_2\text{O}_3^{2-} \rightarrow 3 \text{I}^- + \text{S}_4\text{O}_6^{2-}$, are shown in Fig. 1.

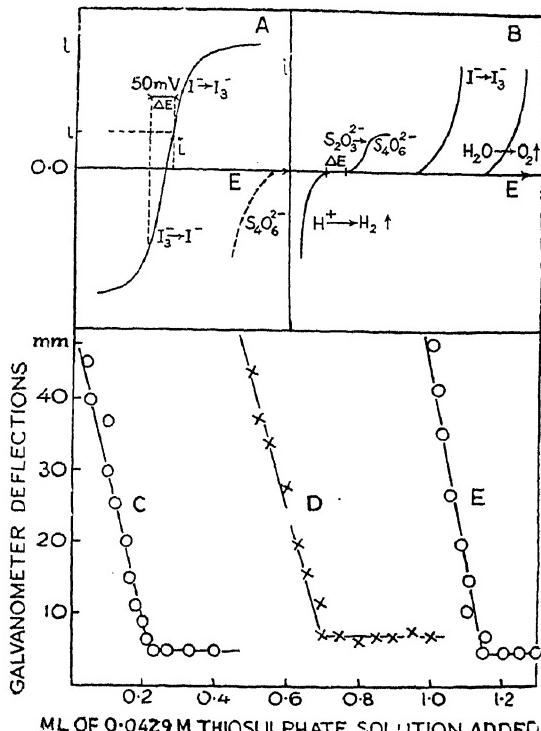


FIG. 1. The current-potential curves : (A) before the equivalence point; (B) after the equivalence point; the amperometric titration curves of 20 ml. of (C) 0.00242 M, (D) 0.00148 M, and (E) 0.000493 M copper sulphate in acetate buffer at pH 4.6 against 0.0429 M sodium thiosulphate solution at 0.05 volt with two polarised electrodes.

Analar pure reagent grade copper sulphate was used to prepare the decimolar stock solution in air-free water, and thiosulphate was Merck's extra pure product. All the other chemicals were C.P. reagent grade products. The stock solutions were standardized potentiometrically, and used after appropriate dilutions with conductance water. The titration vessel was a beaker of 100 ml. capacity, and contains the aliquot, 20 ml. of the titrate in acetate buffer, pH 4·6, with an excess of potassium iodide; it was covered with a tight-fitting rubber stopper provided with holes for the two platinum electrodes, in- and outlet tubes for carbon dioxide, and burette. The titrant was administered from 2 ml. semi-microburette with 0·01 divisions. A constant voltage of the order of 0·05 volt was applied to the electrodes; this value was arrived at empirically. The current through the cell was measured with a mirror galvanometer with a lamp and scale device, and the solution was stirred uniformly during the titration. The equivalence point was determined graphically, and the results are recorded in Table I.

TABLE I

Amperometric iodometric determination of copper (II)

Volume of the titration mixture = 20·0 ml.
Temperature = 25·0° C.

Initial millimolar Concentration of the titrate	Amount of copper (II) in mg.		Experimental • value %
	Taken	Found	
4·80	6·111	6·082	99·50
3·57	4·546	4·578	100·71
2·42	3·085	3·109	100·80
1·48	1·883	1·892	100·49
1·02	1·300	1·297	99·77
0·493	0·6270	0·6186	98·70

In the pre-equivalence region, both components of the reversible couple exist in solution and an appreciable current flows through the cell. After the equivalence point there would be no tri-iodide ion left in the solution, and the limiting current corresponding to the cathodic branch of the current-potential curve for the couple $I^- - I_3^-$ is virtually equal to zero. Both components of the couple $S_2O_3^{2-} - S_4O_6^{2-}$ are present in solution, but practically no current flows through the cell, since this couple is irreversible; the applied potential to the cell is 50 mV, and the total resistance of the circuit generally does not exceed a few thousand ohms; the current under these condi-

tions would be of the order of a few microampere if there is no concentration polarization. The corresponding titration curves have the shape shown graphically to exemplify a few experimental results in Fig. 1 (cf. Curves C, D and E). The slope of these curves is the function of concentrations of the titrate.

Results obtained are accurate and precise and 0·63 mg. of copper (II) can be titrated with an error of about 1·5%. The method yields good results in presence of silver, lead, bismuth, stannic tin, aluminium, zinc and nickel. Ferric iron can be rendered harmless by the addition of a sufficient quantity of alkali pyrophosphate. The electrode assembly is very simple and no reference electrode is needed.

Electrochemical Lab., D. SINGH.
Banaras Hindu University, V. S. AGARWALA.
Banaras, October 26, 1960.

- Oesterheld, G. and Honegger, P., *Helv. Chem. Acta*, 1919, **2**, 410.
- Foulk, C. W. and Bawden, A. T., *J. Am. Chem. Soc.*, 1926, **48**, 2015.
- Pring, M. E. and Spencer, J. F., *Analyst*, 1930, **55**, 375.
- Stone, K. G. and Scholten, H. G., *Anal. Chem.*, 1952, **24**, 671.
- Prasad, B. B., Singh, D. and Prasad, B. N., *J. Sci. Res.*, Banaras Hindu University, 1959-60, **10**, 73.

TITRATION COULOMETER

TITRATION Coulometer is generally used for measurement of quantities of electricity less than 10 coulombs.¹ A modified form of this described below may be used to measure larger quantities of current of the order of 80 coulombs or more. Concentrated solution of sodium chloride is used as the electrolyte and the catholyte and the anolyte are separated by a cation exchange membrane previously equilibrated in the sodium chloride solution to be used in the coulometer. The cation exchange membrane prevents the anodic chlorine from contacting the sodium hydroxide formed in the cathode compartment and minimizes, because of reduced pore size and of small concentration differences maintained in the electrolytic cell, the diffusion of ions from one side to the other. Being itself a good conductor, the membrane offers little resistance to the flow of electric current unlike porous diaphragms normally used in this type of work. The electrodes are of bright platinum foil.

The main features of this coulometer are that it (1) does not require costly materials as in the case of silver or Iodine coulometer;

(2) requires but little attention; (3) is suitable for intermittent use and (4) can be used over and over again when once set-up by merely charging the cell with fresh sodium chloride solution.

Materials required are sodium chloride solution of a concentration in the range 1 N to saturation and an ion-exchange membrane.

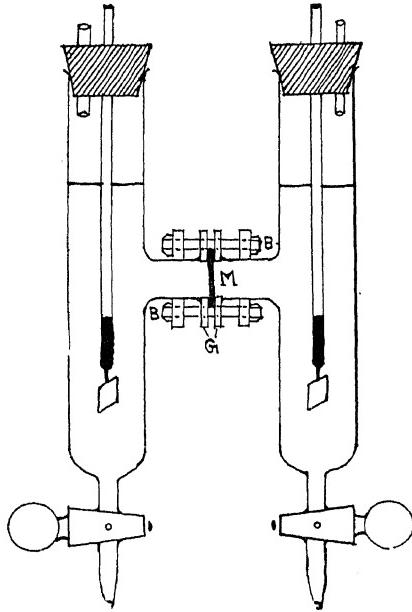


FIG. 1. M = Membrane; B = Brass Bar; G = Rubber Gasket.

An H-type cell (Fig. 1), capacity of each half cell being about 50 ml., bisected by a sodium phenol sulphonate membrane, is used. About 20-30 mA. of current is passed through the cell for about an hour. Larger quantities of current (> 100 coulombs) could be passed by increasing the capacity of the half cells. Otherwise, if larger concentration changes during electrolysis are allowed to build up, ordinary osmotic flow of solvent and diffusion of electrolyte across the membrane are likely to take place and vitiate the results.

After the experiment, the catholyte is drained off and the cathode chamber is washed three times with distilled water. The drained off liquid with the washings is titrated against a standard acid using screened methyl orange as the indicator.

The results obtained with a silver coulometer in series with a membrane coulometer presented in Table I indicate the high order of accuracy obtainable with the titration coulometer.

TABLE I

Concentration of external electrolyte solution (NaCl)	Titration coulometer Milli-equivalents of NaOH formed	Silver coulometer Milli-equivalents of silver deposited
1.0 N	0.7467	0.7461
2.0 N	0.7713	0.7702
3.0 N	0.8692	0.8702
Saturated	0.7630	0.7640

Physical Chem. Lab., V. SUBRAHMANYAN.
Univ. of Madras, N. LAKSHMINARAYANAIAH.
A. C. College of Technology,
Madras-25, October 5, 1960.

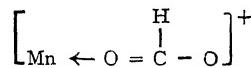
1. Potter, E. C. *Electrochemistry, Principles and Applications*, Cleaver-Hume Press Ltd., London, 1956, p. 16.

FORMATION OF Mn (II)-FORMATE COMPLEX

COMPLEX formation of Mn (II) has been studied by electrometric methods employing the aliphatic monocarboxylic acid series like acetic acid¹ and propionic acid² but not with formic acid. We have, therefore, taken up the study of the nature of complex formation between Mn (II) and sodium formate by the conductometric method.

For conductivity measurements (at $25^\circ \pm 0.1$) different sets of solutions were prepared by keeping the concentration of Mn^{2+} constant and varying that of sodium formate. In all cases the total volume was made constant by adding water. When a graph is plotted between the conductance and composition, a clear break at 1 : 1 is observed. This has been confirmed by the Job's method of continuous variation³ at various compositions, e.g., M/10, M/20, M/30 and M/40 each of $MnCl_2$ and sodium formate. A graph was plotted between the difference in conductance and the ratio $[R]/[R] + [M]$ where [R] stands for the concentration of the ligand used and [M] for the concentration of the metal ion. A maximum in all the cases was found at 0.5 indicating clearly the formation of a 1 : 1 complex between them.

The structure of the complex assigned is :—



which is supported by the value of the dissociation constant given below.

The value of the dissociation constant has also been determined by the Job's method³ with non-equimolecular solutions using the enlarged equation of Job. In our case since $m=1$ and

$n = 1$ (being a 1:1 complex) the equation reduces to

$$K = \frac{C [(P + 1)x - 1]^2}{(P - 1)(1 - 2x)}$$

where K = the dissociation constant of the complex, C = the concentration of the metal ion, P = the ratio of the concentration of the ligand and the metal ion solution and x = the maximum amount of the ligand employed.

The average value of the dissociation constant obtained is 1.503×10^{-4} at $25^\circ C$.

The authors wish to express their grateful thanks to Prof. A. K. Bhattacharya for his helpful suggestions and keen interest in this work.

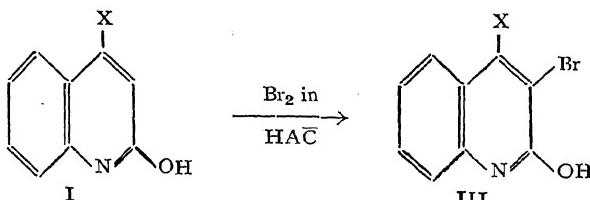
Chemical Lab., M. S. KACHHAWAHA,
University of Saugar, ARUN K. BHATTACHARYA,
Saugor (M.P.), November 15, 1960.

1. Siddhanta, S. K. and Banerji, S. N., *J. Ind. Chem. Soc.*, 1958, **35**, 323.
2. — and —, *Ibid.*, 1958, **35**, 349.
3. Job, P., *Compt. rend.*, 1925, **180**, 928.

BROMINATION OF 2, 4-SUBSTITUTED QUINOLINE DERIVATIVES

RIEGEL *et al.*¹ have prepared 3-bromo-4-quino-linol on bromination of 4-quinolinol in warm glacial acetic acid with bromine. Surrey and Cutler² have reported preparation of 3-halo-2, 4-substituted quinolines by means of sulphuryl chloride, bromine or iodine monochloride in glacial acetic acid. Meyer *et al.*,³ by brominating 2, 4-substituted quinoline, also obtained its 3-bromo derivative. Chick and Wilsmore,⁴ by direct bromination prepared 3-bromo-2-hydroxy-4-methylquinoline, which was shown to be identical with the product obtained by cyclisation of monobromo acetoacetanilide with concentrated sulphuric acid.

A number of 3-bromoquinoline derivatives (III), using bromine in acetic acid in presence of a trace of iodine as catalyst, has been prepared from 2, 4-substituted quinolines (I). These 3-bromoquinolines (III) have also been obtained by cyclisation of monobromo acetoacetyl amides and of monobromo malonmono-arylamides (II).



(X = $-CH_3$ or $-OH$; R = $-C_6H_5$, $-C_7H_7$, $-C_8H_9$ or $-C_{10}H_7$).

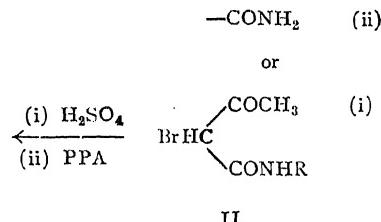
2-Hydroxy-4-methylquinolines have been prepared by the method of Ewins and King,⁵ while 2, 4-dihydroxyquinolines by that of Mehta and Patel.⁶ These 3-bromo quinoline derivatives are crystallized from alcohol in white needles.

Acetoacetyl amides^{5,7} on bromination, gave corresponding monobromo derivatives, which, on cyclisation with concentrated sulphuric acid, yielded 3-bromo-2-hydroxy-4-methylquinolines; whereas the respective monobromo derivatives from malonmonoaryl amides,^{8,9} on cyclisation with polyphosphoric acid at $140^\circ C$, gave 3-bromo-2, 4-dihydroxyquinolines. These 3-bromoquinolines, obtained both by direct and indirect methods, are found to be identical by determination of their melting points and mixed melting points.

One of the authors (G. H. P.) is thankful to M.S. University of Baroda for a Research Assistantship to carry out this work.

Chemistry Department, C. M. MEHTA.
Faculty of Science, G. H. PATEL.
M.S. University of Baroda,
Baroda, September 22, 1960.

1. Riegel, B., Lappin, G. R., Albisetti, C. J. Jr., Adelson, B. H., Dodson, R. M., Ginger, L. G. and Baker, R. H., *J.A.C.S.*, 1946, **68**, 1229.
2. Surrey, A. R. and Cutler, R. A., *Ibid.*, 1946, **68**, 2570.
3. Andre Meyer and Paul Heimann, *Compt. rend.*, 1936, **203**, 264; *C.A.*, 1936, **30**, 7114.
4. Chick, F. and Wilsmore, N. T. M., *J.C.S.*, 1910, **97**, 1990.
5. Ewins, J. A. and King, H. H., *Ibid.*, 1913, **103**, 104.
6. Mehta, C. M. and Patel, G. H., *J. Sci. and Indust. Res.*, 1959, **18B**, 391.
7. Naik, K. G., *et al.*, *J.I.C.S.*, 1932, **9**, 127; 1943, **20**, 384.
8. Whiteley *et al.*, *J.C.S.*, 1903, **83**, 24.
9. Mehta, C. M. and Patel, G. H., *Curr. Sci.*, 1959, **28**, 200.



DEFICIENCY OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE—OBSERVATIONS ON A SAMPLE FROM BOMBAY

It has been observed that certain drugs like primaquine, sulphamamide, etc., induce an acute haemolytic anaemia in some patients.^{1,2} Favism also exhibits similar symptoms.³ The concentration of reduced glutathione was found to be lower in primaquine-sensitive individuals than in others.⁴ This reduction in the average GSH concentration has been traced to a deficiency in the enzyme, glucose-6-phosphate dehydrogenase, in the erythrocytes of sensitive individuals.⁵

This enzyme deficiency has been observed in American Negroes,⁶ Sephardic Jews,⁷ Italians,⁸ Greeks⁹ and some African populations. It is rare or almost absent in Northern European and American Whites¹⁰ and Ashkenasic Jews.⁷

A relatively high incidence of primaquine-induced haemolytic anaemia reported earlier in Indians¹¹ suggested that the deficiency of glucose-6-phosphate dehydrogenase might be present among them. The present study comprising of an unselected sample of 110 individuals from Bombay City confirm this suggestion.

TECHNIQUE

In order to make the method suitable for fieldwork, it was standardized using finger prick blood. The blood sample was collected in 3.8% citrate solution. The criterion for the test was the disappearance of the dye¹² brilliant cresyl blue, as suggested by Dickens and Glock¹² and Motulsky and Campbell.¹³

The method is based on the fact that TPN⁺ in the reaction is reduced to TPNH. The H⁺ is then passed over to the dye which becomes colourless when reduced.

The reaction mixture consisted of :—

(ml.)	
0.04	washed erythrocytes
0.50	distilled water
0.50	0.2 M Tris buffer, pH 7.5
0.10	0.3 M MgCl ₂
0.10	0.02 M Sodium G-6-P
0.25	TPN (100 µg.)
0.20	Brilliant cresyl blue (1×10^{-3} M)

The mixture was covered with 1 ml. of liquid paraffin to avoid contact with air and was kept at 37°C.

Most of the samples started decolorisation between 2 hours 45 minutes and 4 hours after the start of reaction. The samples which did not start decolorization up-till 4 hours and 30

minutes were taken as deficient; the earliest one showing a time of 4 hours and 40 minute

'TABLE I
Time (in hours) taken for the start of decolorisation'

Time	No. of persons	
	Male	Female
≤1.35	1	..
2.25-2.50	..	..
2.50-2.75	9	2
2.75-3.00	12	8
3.00-3.25	12	5
3.25-3.50	17	3
3.50-3.75	9	..
3.75-4.00	14	2
4.00-4.25	1	..
4.25-4.50	..	..
4.50-4.75	3	1
4.75-5.00	3	2
>5.00	..	6
	81	29

All the samples were tested on the day collection.

RESULTS

110 individuals, consisting of 81 males and 29 females between ages 20 and 40 were tested. 6 males and 9 females were found to be deficient for the enzyme (see Table I). The enzyme deficiency is considered to be controlled by a sex-linked, incomplete dominant gene. The female heterozygotes may give test results ranging all the way from normal to abnormal.

The distribution of normal and deficient individuals by community is given in Table II.

'TABLE II
Community distribution of the individuals tested'

	Males		Females	
	Total	Def.	Total	Def.
1 Maharashtra—Hindus	..	35	..	8
2 Konkan—Hindus—Saraswats	10	2	5	1
3 Parsis	..	3	..	9
4 Christians	..	12	..	1
5 Others	..	21	4	6
	81	6	29	9

The enzyme deficiency appears to be widely distributed in the country as the deficient individuals originated from Maharashtra, Gujarat, Mysore and Kerala. As many as 5 out of Parsi females tested were deficient, some of them taking more than 6 hours for the start of decolorization. Saraswats of Konkan showe

3 deficient individuals out of 15 tested. Further investigations in some of these communities are in progress.

We are greatly indebted to Dr. V. R. Khanolkar for the sustained and deep interest he has shown in this investigation. We wish also to acknowledge our gratitude to all those who willingly co-operated with us by giving us blood.

Blood Group Ref. Centre, A. J. BAXI.
and
Human Variation Unit, V. BALAKRISHNAN.
Indian Cancer Res. Centre, L. D. SANGHVI.
Parel, Bombay-12,
December 10, 1960.

of these plant nutrients. In an attempt to standardise a method for routine work in this laboratory, several methods reported in the literature were tried.

Several widely different methods of extraction of mineral nitrogen have been used by different workers. For example, Piper (1950) has reported the use of the classical method of extraction using a mechanical shaker for one hour with 2 N potassium chloride solution at pH 1.0 to 1.5. Cornfield (1952), on the other hand, treated the soil with animal charcoal plus 0.5 N sodium acetate solution for one minute before determining the nutrients in the extract colorimetrically. Rodrigues (1954) treated the soil repeatedly over a filter-paper with N potassium chloride solution at pH 1.0 for the determination of ammonia. In a publication of the Association of Official Agricultural Chemists (1945), a method is described in which precipitated calcium carbonate is used for the clarification of the soil extracts in the colorimetric determination of nitrate.

Freshly sampled up-country Ceylon tea soils rarely contain more than 5 p.p.m. nitrate; various colorimetric methods were tried in order to measure these minute quantities of nitrate, but they gave highly variable results and sometimes the colour could not be matched against the standard. The method of reduction of the nitrate to ammonia (Piper, 1950) and its subsequent determination is probably more accurate but considerable difficulties were encountered in adopting this method also. Using even the most efficient spray catchers during the distillation, the blanks were found to give high and variable results due to the alkali-spray passing over into the distillate. Attempts were made to choke the spray fluid with glass beads, glass wool, etc., but with no improvement. It was therefore thought that a double distillation carried out as one process, would obviate these difficulties. This paper gives a brief description of the methods used and the results obtained.

METHODS

A micro-distillation apparatus (Kjeldahl) was used, but in place of the steam generator there was a 500 ml. flask containing the test solution, connected to the main distillation apparatus through a simple spray catcher. A small quantity of magnesium oxide was introduced into the second distillation tube which was heated by a micro-burner. An aliquot of the soil extract containing at least 0.2 mg. nitrate nitrogen was treated with magnesium oxide plus Devarda's alloy and distilled very slowly.

A MODIFIED METHOD FOR THE DETERMINATION OF AMMONIA AND NITRATE IN CEYLON TEA SOILS

INTRODUCTION

DURING the course of our work on the mineralisation of the organic nitrogen in Ceylon Tea soils, considerable difficulties were encountered in obtaining comparable results when different methods (as reported in the literature) were used for the determination of ammonia and nitrate. It has generally been the practice of each agricultural laboratory to use only one particular set of methods for the routine analysis

(30-45 mins.) into standard acid. Any alkali-spray passing over the first distillation flask was held up in the second distillation tube.

EXPERIMENTAL RESULTS

1. Recovery of ammonia and nitrate nitrogen from an artificial mixture of nutrients.—The results of experiments on recovery from a mixture of standard ammonium chloride and potassium nitrate solution are shown in Tables I and II. It is evident from the results shown in Table II, that a slow rate of distillation is imperative for the quantitative recovery of the nitrate nitrogen.

TABLE I

Recovery of ammonia from a mixture of ammonium chloride and potassium nitrate

Experiment No.	Mineral nitrogen present in the mixture		Ammonia nitrogen recovered (μg.)	% recovery
	Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)		
1	1000	1000	986	98.6
2	1000	2000	998	99.8
3	1600	3000	988	98.8
4	2000	1000	2036	101.8
5	3000	1000	2987	99.6

TABLE II

Recovery of nitrate from a mixture of ammonium chloride and potassium nitrate

Experiment No.	Period of distillation (minutes)	Mineral nitrogen present in the mixture		Nitrate nitrogen recovered (μg.)	% recovery
		Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)		
1	20 (Normal)	1000	1000	915	91.5
2	10 (Fast)	1000	2000	1158	57.9
3	20 (Normal)	1000	3000	2374	79.1
4	30 (Slow)	..	2000	2001	100.0
5	30 (Slow)	..	2000	1982	99.1

2. Recovery of added ammonia and nitrate from tea soil.—200 g. of St. Coombs cultivated top soil (0-6") was mixed thoroughly with known quantities of ammonium chloride plus potassium nitrate and extracted with 400 ml. of 2 N. potassium chloride solution (adjusted to pH 1.0 with hydrochloric acid) in a mechanical shaker for one hour. The extract was filtered through No. 42 Whatman filter-paper and a suitable aliquot of the filtrate was used for the determination of ammonia and nitrate by the above method. Relevant blanks were run and the necessary corrections made for the moisture present in the soil.

Typical results of recovery experiments are shown in Tables III and IV.

TABLE III
Recovery of added ammonia from the tea soil

Experiment No.	Mineral nitrogen added to the soil		Total ammonia nitrogen present in the soil (calculated)	Ammonia recovered (μg.)	% recovery
	Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)			
1	None	None	..	1426	..
2	500	500	1926	1920	99.7
3	500	1000	1926	1900	98.7
4	1000	500	2426	2426	100.4

TABLE IV
Recovery of added nitrate from the tea soil

Experiment No.	Mineral nitrogen added to the soil		Total nitrate nitrogen present in the soil (calculated)	Nitrate nitrogen recovered (μg.)	% recovery
	Ammonia nitrogen (μg.)	Nitrate nitrogen (μg.)			
1	None	None	..	2191	..
2	500	500	2691	2637	98.0
3	500	1000	3191	3171	99.4
4	1000	500	2691	2695	100.1

SUMMARY

An improved rapid method for the simultaneous determination of ammonia and nitrate present in Ceylon tea soils is described. The classical method of single distillation was found to be unsatisfactory even when using very efficient and modified spray-catchers. On the other hand, a double distillation method using a micro-distillation apparatus was found to be both rapid and efficient for the quantitative recovery of ammonia and nitrate from the tea soil extracts.

Tea Research Institute,
St. Coombs,
Talawakelle, Ceylon,
October 3, 1960.

1. Association of Official Agricultural Chemists, *Official and Tentative Methods of Analysis* (6th Edn., Washington), 1945.
2. Cornfield, A. H., *J. Sci. Fd. Agric.*, 1952, 3, 343.
3. Piper, C. S., *Soil and Plant Analysis* (University of Adelaide, Australia), 1950.
4. Rodrigues, G., *J. Soil Sci.*, 1945, 5, 264.

**OCCURRENCE OF
KYANITE-QUARTZITE FROM VARUNA
SCHIST BELT, MYSORE**

A SMALL belt of hornblende schist, occurs 3 miles to the east of Chamundi Hill, near the village Varuna, Mysore District, which is considered to be the extension of the Nagamangala schist belt, occurring as discontinuous stringers and patches.¹ The schist belt runs over 7 miles northwards, from Varuna village with a width of 2-4 furlongs. The belt forms a small ridge whose trend is also N-S. The rock is composed of big prismatic crystals of hornblende ranging in size from 1"-1½" in length, and garnet. The belt is bordered on either side by hornblende gneiss. Amidst this schist belt are found small narrow intercalated bands of kyanite-quartzite, which is very localised in its occurrence. Its strike is N 20°W to S 20°E, and dips at an angle of 70° towards north-east.

The schist belt comprises of rocks which are essentially amphibolites, hornblende schists and quartzites. The amphiboles of amphibolites have a tinge of brown colour along the 'Y' direction. This amphibole resembles the amphiboles generally reported from charnockites.² The rocks are typically granulitic in texture. Their mineral composition may vary from plagioclase-diopside-granulite, to amphibole-hypersthene granulite to pure amphibole granulite.

The plagioclase-amphibole granulites have plagioclasses of 35% anorthite, and the amphiboles have the following optical characters:

(-)2V = 79°; ZAC = 17°; ($\gamma - \alpha$) = 0.020;
X = brownish-yellow, Y = yellowish-green,
Z = dark-green.

The amphibole sometimes shows a sieved structure, indicating thereby that the amphibole has developed at the expense of pyroxene. Quartz is always rounded and occurs both in amphibole and in the rest of the slide. The diopside is cloudy, traversed by cracks and dotted with iron-ore, whereas the amphibole is clear. The amphibole in such cases where there are relics of diopside are intensely pleochroic.

There are amphibolites in the schist belt in which the diopside and hypersthene have disappeared and the resulting rock is composed entirely of strongly pleochroic amphibole and quartz. In these amphibolites the sieve structure is more evident. The amphiboles may pass on to granules of garnet. In hand specimen, these amphiboles have needle-like habit and may be called appinites. Sometimes there are occasional pockets of bronzite³ included among the schists.

The kyanite-quartzite exhibits a mosaic texture composed of quartz, kyanite, sillimanite and mica. The optical characters of sillimanite are: (+) 2V = 29°; ($\gamma - \alpha$) = 0.027. The accessories are sphene, rutile and pyrite. The quartz gives faint undulose extinction. Some of the quartzes show regular banding. Occasionally the kyanite is converted into sericite mica (refer Fig. 1).



FIG. 1

There are also bands of intercalated fuchsite quartzites with accessory rutile and sphene. The rutile or sphene sometimes alter to a brown patch, possibly limonite(?). There are relics of kyanite within these fuchsite bands. The optical properties of fuchsite are: $\gamma = \beta = 1.597$; ($\gamma - \alpha$) = 0.038; (-) 2V = 30°; XZ plane perpendicular to (010).

Kyanite from kyanite-quartzite was separated by heavy liquids and chemically analysed. Its chemical composition is: SiO₂ = 37.60, Al₂O₃ = 61.83, Fe₂O₃ = 0.35, H₂O = 0.32, total = 100.10. The empirical formula computed from the chemical composition conforms with the formula for kyanite given by Dana.⁴

The optical characters of the kyanite are: (-) 2V = 84°; ($\gamma - \alpha$) = 0.012; ($\beta - \alpha$) = 0.007; ZAC = 24°; Sp. Gr. = 3.589.

The occurrence of kyanite-quartzite with the hornblende-hypersthene granulites of Varuna schist belt has for the first time been reported by the present author. The association points to the high grade metamorphism of the schists in the Varuna area, which is in accordance with the general increase in the metamorphic grade of the rocks of Mysore State, where, metamorphism increases from north to south. Actually the

Varuna schist belt is situated at the south-western extremity of the Mysore State.

Dept. of Applied Geology,
University of Saugar,
Saugor, September 24, 1960.

S. K. BABU.

1. Sampath Iyengar, P., *Rec. Mysore Geol. Dept.*, 1905-07, 7, 22.
2. Naidu, P. R. J., *Schweiz. Miner. Petr. Mitt.*, 1954, 34, 253.
3. Balu, S. K., *J. Madras Univ.*, 1956, 26 B, 243.
4. Dana, E. S., *Text-Book of Mineralogy*, 4th Edition, John Wiley, 1955, 617.

EMPLACEMENT OF PEGMATITES IN KONDAPALLE AREA

DURING the course of detailed geological mapping of the Kondapalle hills, the author came across a large number of pegmatite exposures. As many as 75 exposures were studied on the lines suggested by Goodspeed¹ and Chandwick,² in order to know the exact mode(s) of their emplacement. Only a small number of these pegmatites exhibit features which can be used as criteria for distinguishing their modes of emplacement.

a singular structural evidence of displacement of a wall rock unit (basic charnockitic band), proportional to the width of pegmatite and angle of intersection. This is the most useful criterion for identifying a dilational pegmatite. Where the pegmatites occur in granite-gneisses, the latter are much disturbed and folded; the foliation of wall rock gneisses has become parallel to the contacts of the pegmatite and is bent in the same direction on both walls of the pegmatite (Fig. 1). These features are supposed to have resulted when the pegmatite during intrusion dragged the adjacent rocks toward parallelism with its borders, but not due to post-emplacement deformation. This is further corroborated by the absence of signs of shearing along the pegmatite margins and of indications of deformation in the pegmatite minerals. Hence it is supposed that forceful emplacement is a significant mechanism by which these pegmatites were emplaced.

Some of the pegmatites which are lens-like were probably developed during permissive emplacement, as no evidences of forceful emplacement are met with. Since there is no

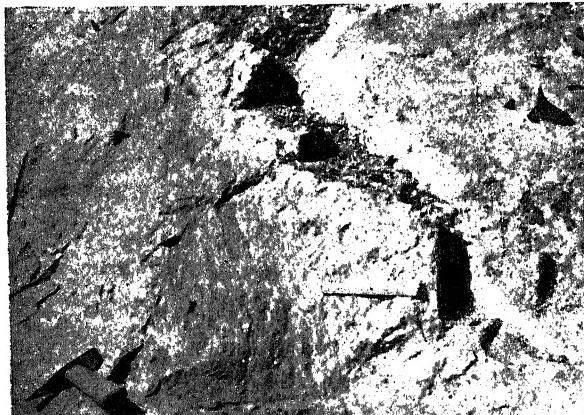


FIG. 1

The pegmatites are relatively coarse-grained and are granitic in character containing quartz and alkali feldspar (perthitic) as essentials. They generally occur as straight tabular bodies and rarely as lens-shaped ones in the charnockites or granite-gneisses. The colour of the pegmatites is either grey or pink and their width varies from a few inches to fifty inches, and the length from a few feet to many tens of feet. Their general trend is between NNW and NNE directions.

The pegmatites in general have an apparently sharp contact with the charnockites and a gradational one with the granite-gneisses. There is

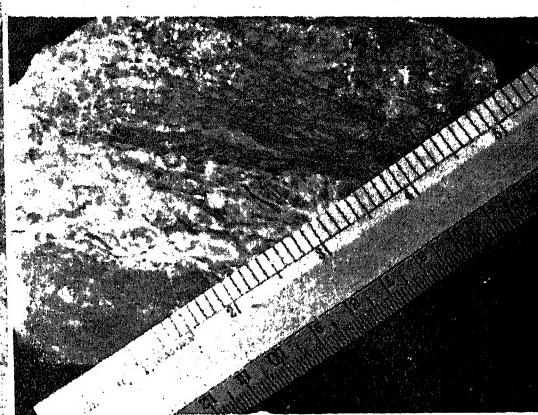


FIG. 2

special relationship between pegmatite and adjacent wall rock compositions, it is not possible to distinguish displacement from non-displacement.

Introduction was a dominant mobile process during the course of emplacement of those pegmatites whose adjacent walls are enriched in pegmatitic constituents and those which are having narrow offshoots into the gneisses parallel to the gneissosity. It is significant in this connection to note the occurrence of monazite in the granite-gneisses adjacent to the pegmatite, as reported by the author³ earlier.

In contrast to the above, a few pegmatites exhibit features which are considered to be non-dilatational or non-mobile. These features include gradational or diffuse borders, the elongation of the pegmatite minerals in the same direction as the adjacent gneiss and lastly the occurrence of thin stringers of host rock as relics, being arranged parallel to the pegmatitic borders (Fig. 2). The metamorphic-metasomatic theory of Ramberg⁴ can explain to a very large extent these phenomena in a satisfactory manner. In a few cases, interesting evidences for the pegmatite emplacement are noticed indicating the process to be one of a combination of different mechanisms.

The author desires to express his grateful thanks to Dr. S. Balakrishna, for many helpful discussions throughout the work.

Geology Department,
Osmania University,
Hyderabad-7 (India),
November 3, 1960.

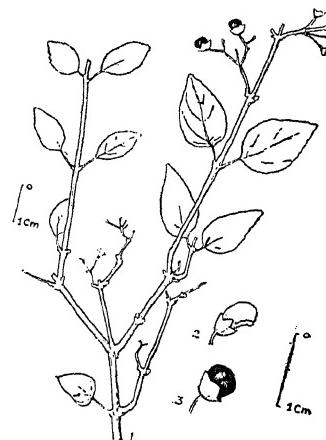
1. Goodspeed, G. E., *Jour. Geol.*, 1940, **48**, 175.
2. Chadwick, R. A., *Geol. Soc. Amer. Bull.*, 1958, **69**, 803.
3. Leelanandam, Ch., *Curr. Sci.*, 1960, **29**, 225.
4. Ramberg, H., *Geol. Soc. Amer. Bull.*, 1956, **67**, 185.

**PREMNA RESINOSA SCHAU.
(VERBENACEAE) AN ADDITION TO
INDIAN FLORA**

HOOKER¹ described 25 species of the genus *Premna* from India. Six more species have been added bringing the total species of this genus in India to 31. Of these, 18 species occur only in the eastern and western Himalayas and the adjoining submontane regions; 13 species occur in the central and southern India.

Cooke² and Talbot³ described only two species *P. coriacea* Cl. and *P. integrifolia* Linn. from Bombay State. While examining the materials of the Verbenaceæ from Kutch some specimens could not be fixed in any of the *Premna* species reported from India. These specimens which had been collected from several localities in Kutch belong to one of the commonest shrubs of the area. It is a large bushy shrub about 2 m. high, with small panicles and black drupes of the size of pea. Indraji Thakar⁵ has described another doubtful species from Kutch *P. herbacea*? The description given by Indraji Thakar under the name *P. herbacea*? resembles this material but the name *P. herbacea* for it is obviously wrong as *P. herbacea* Roxb. is a small undershrub only few cm. high, with an inconspicuous stem and large leaves (Hooker, loc. cit.).

Santapau probably collected this very plant from Saurashtra. He followed Indraji Thakar's conception as he doubtfully mentions *P. herbacea* Indraji in his list.⁶ The Kutch plants agreed with the description of *Premna resinosa* (Hochst.) Schau. This specimen was referred to the Keeper of the Central National Herbarium, Calcutta, who confirmed the identification. This species is not reported so far from India. It occurs in Tropical Africa and Arabia.



FIGS. 1-3. *Premna resinosa* Schau.

Fig. 1. A part of plant. Fig. 2. A flower. Fig. 3. A fruit.

P. resinosa (Hachst.) Schauer in *Dc. Prodr.*, 11, 637; Dyer, *Fl. Trop. Afr.*, 1900, 5, 289; Blatter, *Fl. Arabia, Rec. bot. Surv. India*, 1921, 8 (3), 365; Andrew, *Fig. Pl. Sudan*, 1956, 3, 198.

An erect shrub, about 2 m. high, stem much branched above, branchlets slender, angular, white, glabrous or slightly pubescent; leaves opposite petiolate, entire or distantly crenate, ovate or elliptic oblong, obtuse at apex, 0.8-3 cm. long. Inflorescence of small terminal pedunculate corymbose panicles; flowers very small; calyx small cup-shaped, about 3 mm. long, limb minutely 5-toothed, teeth almost obsolete in fruit; corolla greenish-white, 5 mm. long, 4-lobed, 2-lipped; stamens 4, didynamous, alternating with corolla lobes, not exserted; ovary 4-ovuled; drupe size of a small pea, black, globose.

Dhinodhar-Jain 46917 (20-10-1958); Khavada-Kala Dungar-Jain 61820 (6-4-1960) and 61867 (7-4-1960).

Very common in Kutch in hilly areas on rocky substratum.

The material referred by Indraji Thakar as *P. herbacea*? and Santapau as *P. herbacea* Indraji belongs to this species.

The plant is locally known as 'Kunder' or 'Ghiteli'.

I am grateful to Dr. J. C. Sen Gupta, Dr. S. K. Mukharjee, Shri R. S. Rao and Shri S. K. Jain for their kind advice and help in the preparation of this note.

Herbarium, MISS U. R. DESHPANDE,
Botanical Survey of India,
Western Circle, Poona, June 13, 1960.

1. Hooker, J. D., *Flora of British India*, London, 1885, 4.
2. Cooke, T., *Flora of Bombay*, London, 1908, 2.
3. Talbot, W., *Forest Flora of Bombay* London, 1911, 2.
4. Blatter, E. J., "On Flora of Kutch," *J. Bombay Nat. Hist. Soc.*, 1908, 19, 157.
5. Indraji Thakar, J., *Plants of Kutch and their Utility* (in Gujarati), Bombay, 1926.
6. Andrews, *Flowering Plants of Sudan* 1956, 3.
7. Dyer, T., *Flora of Tropical Africa*, 1900, 5.
8. Blatter, E. J., "Flora of Arabia," *Rec. Bot. Surv. India*, 1921, 8 (3), 365.
9. Santapau, H., *Plants of Saurashtra*, Rajkot, 1953.

EFFECT OF INFECTION OF SPHAEOLOTHECA SCHWEINFURTHIANA, THUMEN. ON SPIKELET STRUCTURE IN ERIANTHUS MUNJA

THE occurrence of abnormal and proliferating spikelets consequent on gene action, unfavourable environment and infection by diseases has been commonly noticed. Fungi belonging to the Ustilaginales causing infection of floral organs have been known to induce abnormalities in grasses. In sugarcane, Sharma² has recorded abnormalities in floral structure of sugarcane consequent on the attack of *Ustilago scitaminea*. There is, however, no record of *Sphaelotheca* sp. affecting the genus *Saccharum* or *Ustilago* sp. affecting the genus *Erianthus*.

Among the collections of *Erianthus* species at this Institute, a few forms of *E. munja* have been noticed to be infected by *Sphaelotheca schweinfurthiana*, Khanna and Ramanathan.³ No other species of *Erianthus* is infested. The arrows when fully emerged from the leaf-sheath present a blackish appearance due to the occurrence of sori inside the glumes. All arrows are infested and practically each and every spikelet.

Examination of the spikelets revealed the occurrence of certain abnormalities which are reported here. In the young arrows where only the glumes, palea and lodicules are developed, these floral parts are normal. At a later stage when the essential organs get differentiated, instead of the stamens and pistil a black mass appears at the centre of the individual spikelets transforming the ovary into a smut sorus. This

is developed by a thin, hyaline pseudomembrane. At a later stage abnormalities are noticed in the form of extra glumes, giant-sized lodicules, staminodes, etc. The usual sterile glumes are not affected excepting for a little increase in size. Out of the 50 random spikelets examined, additional glumes were noticed in all excepting four. These vary from one to six per spikelet, the majority recording one or two. When only one extra glume is present, it is a duplication of the third glume. When more than one both the third and fourth glumes (fertile lemmas) are involved. The palea in all cases is normal. The lodicules are often bigger in size with prominent terminal cilia. Often one or both of them are absent.

In the case of the essential organs, the male organs are suppressed and only staminodes are noticed with a short filament and two-lobed, empty anther sacs. In most cases only two staminodes are noticed. The columella characteristic of the genus and consisting of modified ovarian tissue and fungal elements is prominently visible. Normally only one sorus is seen in each spikelet. In a few cases, two sori, independent of each other with two additional glumes subtending each of them are seen.

Thanks are due to Dr. J. T. Rao, Botanist, for help and guidance and to Dr. N. R. Bhat, Director, for interest and encouragement.

U. VIJAYALAKSHMI.
S. MARIMUTHAMMAL.

Sugarcane Breeding Institute,
Coimbatore-7, November 4, 1960.

1. Sharma, S. L., *Proc. Int. Soc. Sug. Tech.*, 1956, 1, 1134-68.
2. Khanna, K. L. and Ramanathan, K. R., *Curr. Sci.*, 1946, 15, 276.

CALOBRYUM NEES—A GENUS NEW TO INDIAN FLORA*

THE genus *Calobryum* is a remarkable member of the Hepaticæ because of its characteristic erect, radially symmetrical gametophytes with three ranked more or less similar leaves—features shared by the only allied genus *Haplomitrium*. Apart from these distinctive vegetative features of *Calobryum* the apical disposition of antheridia and archegonia are as in the mosses. The genera *Calobryum* and *Haplomitrium* have been associated with affinities

* Contribution from the Department of Botany, Lucknow University, India, New Series (Bryophyta), No. 48.

of immense phylogenetic significance (Campbell,¹ Smith,² Fulford³ and Campbell⁴) and are regarded as the most primitive of the liverworts.

Calobryum, with its four (Campbell⁴) or five (Campbell¹) known species, has a very restricted distribution and is primarily confined to the southern hemisphere with an extended northern range in Japan. The present report of this interesting plant from India thus not only extends the range of distribution of this rare liverwort but also constitutes a significant addition of such an important genus to our Hepatic flora. The plant was collected by one of us (Udar) from Ghoom (alt. ca. 6,500 ft.) in Darjeeling on January 2, 1959.

The specimens collected are fertile. However, mature sporophytes are not represented although several young stages are present. The main taxonomic features of the Darjeeling specimens are described below:

The plants are up to 1.5 cm. in length. The erect gametophores are gregarious and arise from a tangled mass of rhizomes which are interwoven with several leafy liverworts. The rhizomes grow to some length and then curve upwards (Figs. 1, 3, rh) forming the leafy

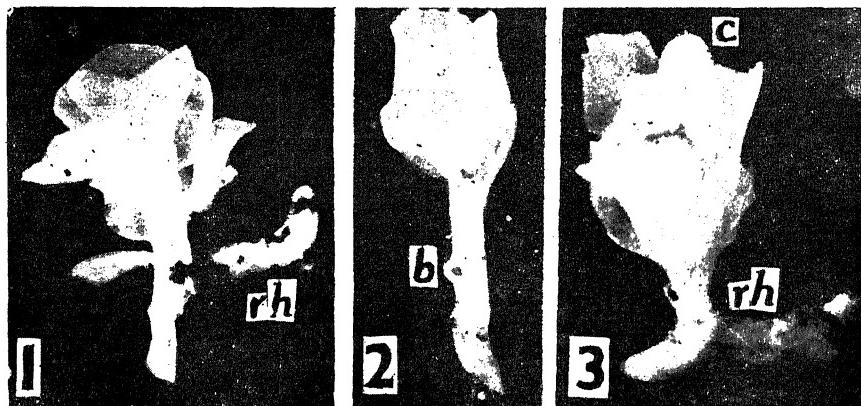
The female plants (Figs. 2, 3) have the three rows of leaves compactly arranged particularly towards the apex. They surround the developing archegonia effectively and expand out in later stages. About 25 mature archegonia were counted. These have the characteristic long necks which towards the terminal portion have twisted rows of cells.

The young sporophyte is surrounded by a massive "calyptra" (Fig. 3, c) which is cylindrical and is up to 8 mm. long. It carries several fertilised or shrivelled archegonia at its base and often also towards the apex.

Though in its external morphology the specimens from Darjeeling approach *Calobryum gibbsiae* St.—a species known from New Zealand (Campbell⁴)—yet in the size of the leaves and its cells as well as developmental details of antheridia, archegonia and the embryo there are significant differences. A fuller discussion embodying these details will shortly be published elsewhere.

Department of Botany,
Lucknow University,
Lucknow, June 7, 1960.

RAM UDAR.
SATISH CHANDRA.



FIGS. 1-3. Fig. 1. A male plant. rh, rhizome. Fig. 2. A young female plant. Note the close aggregation of the leaves at the apex. b, point at which rhizome has broken. Fig. 3. A female plant with a young sporophyte. c, conspicuous cylindrical "Calyptra"; rh, rhizome. (All figures, $\times 10$.)

gametophores. The entire plant completely lacks rhizoids but numerous multicellular mucilage hairs occur on them.

The male plant (Fig. 1) has the leaves loosely disposed which are normally all alike. The compact growth of the thalli, however, results in comparatively smaller leaves at the base and larger towards the apex. There are well over 100 antheridia in different stages of the development at the apex of the male shoot.

1. Campbell, D. H., *The Evolution of the Land Plant (Embryophyta)*. Stanford University Press, California, 1940.
2. Smith, G. M., *Cryptogamic Botany (Bryophytes and Pteridophytes)*, McGraw-Hill Book Co., Inc., U.S.A., 1955, 2.
3. Fulford, M., *Phytomorph.*, 1958, 8, 298.
4. Campbell, E. O., *Trans. Roy. Soc., New Zealand*, 1959, 87, 245.

OCCURRENCE OF ACRASIALES IN INDIAN SOILS

In a recent letter on soil micro-fungi of Uttar Pradesh, Rai and Tewari¹ say that "nothing was known till now about the members of Acrasiæ inhabiting soils of this country" and that *Dictyostelium mucoroides* Bref. and *Poly-sphondylillum violaceum* Bref. are being reported by them for the first time.

The above statements are not correct. I should like to draw their attention to my paper² published in 1956, in which I have recorded 6-7 species of Dictyosteliaceæ from several soil samples and rhizosphere of diverse species of plants in South India.

The species reported by me are *Dictyostelium mucoroides* Bref., *D. discoideum* Raper, *D. minutum* Raper, *D. purpureum* Olive, *Poly-sphondylillum pallidum* Olive, *P. violaceum* Olive and possibly *Dictyostelium giganteum* Singh.

V. AGNIHOTHRUDU.

Tocklai Experimental Station,
Indian Tea Association,
Cinnamara, Assam, December 12, 1960.

1. Rai, J. N. and Tewari, J. P., *Curr. Sci.*, 1960, 29, 400.
2. Agnihothrudu, V., *Experientia*, 1956, 12, 149.

EFFECT OF INDOLE ACETIC ACID ON THE NITROGEN AND CARBOHYDRATE METABOLISM OF EXCISED WHEAT LEAVES

It was shown by Christiansen and Thimann¹ that during the growth of sections of etiolated pea-stems in indole acetic acid solution a considerable amount of sucrose and reducing sugar was consumed; also the respiration of the tissue was stimulated by 15 to 25% over that of sections grown in water alone. Similar studies conducted with leaf will be especially useful to gather information of a fundamental nature regarding some of the important metabolic processes occurring in plant. In this study such an attempt was made with excised wheat leaves in order to gain some information regarding the nitrogen and carbohydrate changes as influenced by indole acetic acid.

Samples of wheat leaves (var. "Little Joss") weighing 2.0 gm. obtained from 7-day-old seedlings of uniform growth were taken for initial analysis of (1) soluble-N, (2) soluble nitrogen including nitrate, (3) insoluble-N, (4) reducing sugar, (5) total sugar and (6) acid hydrolysable polysaccharide. Similar leaf samples were transferred at known time to Petri dishes which contained (1) 20 ml. of 1% glucose solution

containing N/10 KNO₃ and (2) 20 ml. of 1% glucose solution containing N/10 KNO₃ and 5 p.p.m. indole acetic acid. These were incubated in dark at 27°C. The Petri dishes and the nutrient medium had been previously sterilized. After an interval of 24 hours the leaves were analysed for the different nitrogen and carbohydrate fractions.

The leaves were extracted for total soluble-N as described by Austin.² Total soluble-N and insoluble-N were determined according to the microdiffusion method of Conway.³ Total soluble-N including nitrate was determined by the reduced iron method of Pucher, Leavenworth and Vickery.⁴ Reducing sugar, total sugar and acid hydrolysable polysaccharide were determined according to the Hagedorn-Jenson method.

TABLE I
Changes in the carbohydrate and nitrogen fractions of the leaf

(Mean values of 2 readings are given; values expressed as mgm./1 gm. fresh weight)

Constituent	Initial	Treatments			
		24 hours in sugar-nitrate medium	% increase or decrease from the initial	24 hours in sugar-nitrate medium + 5 p.p.m. I.A.A.	% increase or decrease from the initial
Polysaccharide ..	20.96	21.78	+ 4.1	19.06	- 9.0
Total sugar ..	20.68	20.55	- 0.48	19.58	- 5.3
Reducing sugar ..	19.83	19.74	- 0.45	18.85	- 4.9
Soluble-N ..	0.712	0.918	+28.9	0.975	+36.9
Soluble-N includ- ing nitrate ..	0.719	0.978	+36.0	1.007	+40.1
Insoluble-N ..	2.034	2.424	+19.2	2.461	+21.06

It can be seen from Table I that soluble-N, total soluble-N including nitrate and insoluble-N of the leaf kept in both the solutions increased considerably at the end of the 24-hour experimental period. The leaves floated in sugar-nitrate solution containing indole acetic acid had more total soluble-N and total soluble-N including nitrate than the leaves floated in sugar-nitrate solution alone. As regards insoluble-N the values were more or less the same irrespective of nutrient solutions.

As regards carbohydrates, there was a slight increase of acid hydrolysable polysaccharide in the leaves supplied with the sugar-nitrate medium, whereas reducing and total sugars remained more or less constant. When indole acetic acid was also present in the medium, all these three carbohydrate fractions decreased,

this decrease being more marked with the acid hydrolysable polysaccharide. These changes can be explained in the light of the reactions shown in Fig. 1.

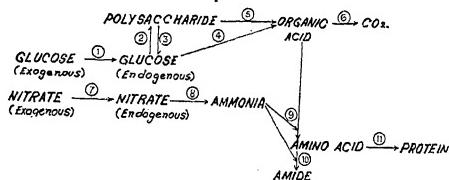


FIG. 1

If reaction 2 is faster than reactions 3, 4, 5 and 6, there will be an increase of polysaccharide, whereas if the reverse is the trend, then a decrease of this fraction will occur. The observed loss of polysaccharide in auxin-supplied leaves suggests that the latter alternative is the trend of metabolic reactions brought about in the leaves by the action of indole acetic acid. This observation is interesting in the light of the finding made by several workers that the application of auxin stimulates the respiration of a tissue. More carbon skeletons will be used as a result of an enhanced rate of respiration, and this, in the present case, will have to be obtained from an oxidative breakdown of reserve carbohydrates (possibly from polysaccharide). When nitrate is also present in the system, reactions 8, 9, 10 and 11 also will occur simultaneously. Thus the observed decrease of polysaccharide must have been possibly due to respiratory destruction as well as to conversion to other non-carbohydrate type of cell constituents. The results presented in Table I furthermore show that with regard to the nitrogen fractions, the effect of indole acetic acid was manifested in the production of more soluble-N (and soluble-N including nitrate) which would indicate that although total soluble-N increased, insoluble-N was not formed. This may indicate that the ready formation of insoluble-N might have been considerably prevented due to a possible non-availability of particular amino-acids necessary for protein synthesis.

I am thankful to Professor W. H. Pearsall, Professor of Botany, University College, London, for providing me facilities to conduct this work at the Botany Department of the University College. I am also thankful to Mr. P. J. Syrett for his suggestions.

Division of Botany, ANSELM AUSTIN,
Indian Agri. Research Institute,
New Delhi-12, August 13, 1960.

1. Christiansen, G. S. and Thimann, K. V., *Arch. Biochem.*, 1950, 26, 245.
2. Austin, A., *Phyton*, 1959, 12, 43.
3. Conway, E. J., *Microdiffusion Analysis and Volumetric Error*, Crosby, Lockwood & Son, Ltd., London, 1947.
4. Pucher, G. W. et al., *Industr. Eng. Chem. (Anal. ed.)*, 1930, 2, 191.

STUDIES ON THE RHIZOSPHERE MICROFLORA OF CITRUS PLANTS AS INFLUENCED BY STREPTOMYCYIN SPRAY

It is well established that the rhizosphere region of plants is the site of increased microbial activity as compared to the soil. Depending upon the plant species, its age, etc., the increase in population may range from a few to a hundred times or even more. The rhizosphere of several annual angiosperms and a few pteridophytes have been studied by several workers but not much work seems to have been done on the perennial plants, except for the report of Obraztsova¹ stating that a two-year-old tea bush harboured more number of micro-organisms than the old flowering tea bushes and also that of Gyllenberg and Hanioja² reporting that grasses harboured greater number of micro-organisms than the trees.

With a view to examine the rhizospheric microflora of acid lime [*Citrus aurantifolia* (Christm.) Swingle] plants, a widely grown perennial orchard tree, studies were undertaken in the Annamalai University Experimental Orchard, Annamalainagar, and the results are reported here. In the recent studies^{3,4} made in the same orchard on the control of the canker disease of acid lime plants caused by *Xanthomonas citri* (Hesse) Dowson, it was observed that streptomycin sprays not only checked the disease but also caused better growth of the plants with fresh dark green shoots as against chlorotic stunted appearance of the unsprayed plants. In order to examine the possible effect of streptomycin in causing any physiological change of the plant, as could be indicated by the rhizosphere population, studies were made and these results also are reported here.

A total of 36 plants, about four years old and in the second year of bearing, were selected in a block in the orchard for these studies. Six plants, selected at random, were sprayed with 1,000 p.p.m., of aqueous streptomycin sulphate (E. R. Squibb & Son, containing 729 units/mg.), together with 1% glycerine, added for better penetration by the spray. The

presence of streptomycin in the leaf, stem and root tissues was examined by the same technique used in the earlier studies. Indications were obtained for the presence of streptomycin in the leaf and stem, starting from 24 hours after spray up to 15 days, but at no time was there any indication for the presence of traceable amount of streptomycin in the root tissues.

To examine the rhizosphere microflora, root samples were collected from the sprayed and unsprayed plants. The soil was dug out carefully and the lateral roots exposed. The tips of young growing roots were selected, avoiding the older ones that have become thick and woody. About an inch long tips were clipped off from the root, the excess soil particles adhering to them removed by gentle tapping and the root bits transferred to 100 ml. portions of sterile tap-water in flasks. From each plant root bits were selected at random from three different radials of the tree. The suspension was then shaken thoroughly and the microbial population assayed by the dilution plate method, using potato dextrose agar and Ken Knight's agar media. The plates were incubated at room temperature for seven days before final counts of the bacteria, actinomycetes and fungi were taken. The original rhizosphere suspension was evaporated to dryness over a water-bath and dry weight of the sample obtained. The total microbial population was calculated on the dry weight basis of rhizosphere sample. For comparison, soil samples collected at approximately the same depth as that of the selected roots, but away from the plants, were assayed for the microbial population.

The results indicate that the rhizosphere of growing roots of acid lime plants has nearly 150 times more of microbial population than that of the soil. The bacteria were 70 to 150 times more in the rhizosphere, the actinomycetes 4 to 20 times and the fungi 4 to 19 times more than those in the soil. The rhizosphere thus seems to favour better growth of bacteria than either fungi or actinomycetes. In these respects acid lime plant appears to be similar to some of the annuals like beans, sunn-hemp, etc.⁵ The streptomycin spray does not seem to significantly change the total microbial population as well as the component bacteria, actinomycetes and fungi, as indicated by the data obtained by examining the roots at periodical intervals after the spraying. The rapid growth of the streptomycin-sprayed acid lime plants may be due to causes other than the quantitative changes in the rhizosphere population.

Dept. of Agriculture, G. RANGASWAMI.
Annamalai University, V. N. VASANTHARAJAN.
Annamalainagar (S. India),
August 31, 1960.

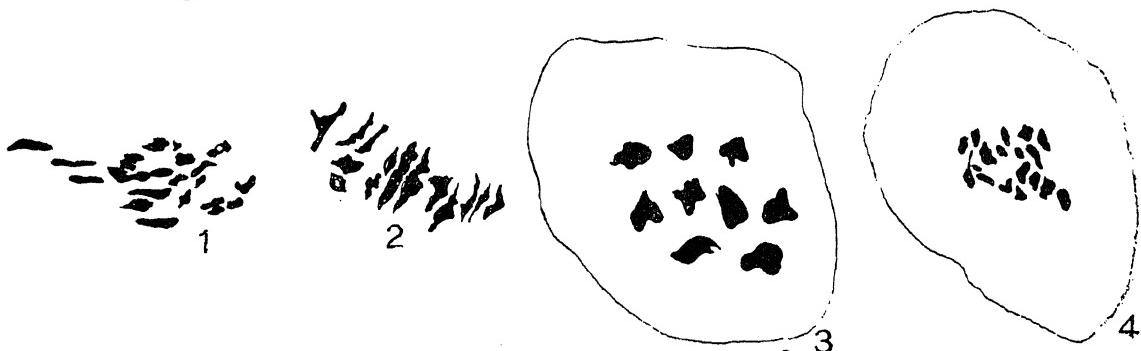
1. Obraztsova, A. A., *Doklady Akad. Nauk S.S.R.*, 1935, **9**, 70 (Katznelson, H. et al., *Bot. Rev.*, 1948, **14**, 543).
2. Gyllenberg, E. and Hanioja, P., *Physiol. Plantarum*, 1956, **9**, 441.
3. Rangaswami, G., Rao, R. R. and Lakshmanan, A., *Phytopathology*, 1959, **49**, 224.
4. —, — and —, *Curr. Sci.*, 1959, **28**, 167.
5. Agnihothrudu, V., *Proc. Ind. Acad. Sci.*, 1953, **37B**, 1.

MEIOTIC STUDIES IN SOME MALVACEOUS SPECIES

CYTOTAXONOMICAL studies of the tribe Malveæ have been undertaken in this laboratory to bring out the details which may help in understanding some controversial points of systematology of the family Malvaceæ. Stray cytological investigations of some wild species in the family Malvaceæ have been done by several authors.¹⁻⁵ The present account deals with five species belonging to four genera. This investigation has brought out new facts regarding the number and configurations of the chromosomes in these species.

Cytological studies were made from acetocarmine preparations of pollen mother cells. Division in general was not found to be synchronous. Observations were taken at the diakinesis, M I and A I. In general appearance the configurations of bivalents, their size and in some cases even the number did not resemble the previous reports.

In *Malva sylvestris*, L., twenty-one bivalents were seen at M I in the PMCs. Some of the bivalents were always in groups showing secondary association. Twelve out of twenty-one bivalents appeared to be associated in four groups of three each. Thus it is suspected that this species may be a polyploid and the basic number may be 7. This is yet to be confirmed from the karyoanalysis of the root-tip mitosis. In *Malvastrum tricuspidatum* A. Gray. twelve bivalents were seen at diplotene. Three of the bivalents were seen to be associated with the nucleolus. In *Sida veronicæfolia*, Lamk. the diploid number reported was 14 or 56.⁴ But at M I in the present studies, only 14 bivalents were clearly seen (Fig. 2). On the other hand, in *Sida acuta*, Burm. nine bivalents were observed at M I (Fig. 3). For this latter species the previous report was 14 or 28.^{3,4} *Abutilon indicum*, Don.: the basic number in the poly-



FIGS. 1-4. Camera lucida drawings of: Fig. 1. M I in *Malva sylvestris*, Don. showing 21 bivalents ($\times 1,500$). Fig. 2. M I in *Sida veronicaefolia*, Lamk. showing 14 bivalents ($\times 1,500$). Fig. 3. M I in *Sida acuta* Burm. showing 9 bivalents ($\times 1,500$). Fig. 4. M I in *Abutilon indicum*, L. showing 18 bivalents ($\times 2,000$).

lobed series of this species was reported to be 7.¹ The present study, however, revealed 18 bivalents at M I (Fig. 4). A consolidated account of the chromosome number determined is given below:

	Name of the species	Chromosome number reported by previous workers	Authors	Present finding
1	<i>Malva sylvestris</i> , L.	2x/42	Skovsted, 1935	2x/42
2	<i>Malvastrum tricuspidatum</i> , A. Gray.	24	Skovsted, 1941	24
3	<i>Sida veronicaefolia</i> , Lamk.	14, 56	Skovsted, 1941	28
4	<i>Sida acuta</i> , Burm.	14, 28	Skovsted, 1935, 1941	18
5	<i>Abutilon indicum</i> , Don.	42	Skovsted, 1941	36

It is evident from the above table that *Malva sylvestris*, L. and *Sida veronicaefolia*, Lamk. have the somatic chromosome number which is multiple of 7. Hence, 7 can be taken as their basic number. In the cases of the other three species *Malvastrum tricuspidatum*, A. Gray., *Sida acuta*, Burm. and *Abutilon indicum*, Don., however, the somatic chromosome numbers are multiple of 6. Thus 6 and 7 both may be looked upon as the base numbers in this tribe. In the previous report the chromosome number of *Sida veronicaefolia*, Lamk. was found to be 14 and 56 whereas in the present investigation it has been found to be 28. This report, therefore, completes the polyploid series in this species. In the natural population, therefore, it appears that plants with 14, 28 and 42 chromosomes are found in the same way as in *Solanum nigrum* and several other species where also the diploids, tetraploids

and hexaploid forms within a single species have been reported. It may be interesting to find out the pollination frequency of the different forms in nature. In the case of *Sida acuta*, Burm. the present investigation contradicts altogether the previous findings. This indicates that *Sida veronicaefolia*, Lamk. and *Sida acuta*, Burm. have evolved from another species on parallel lines and their relationship is therefore remote. *Abutilon indicum*, Don. also falls more in line with *Sida acuta*, Burm. and *Malvastrum tricuspidatum*, A. Gray. than with *Sida veronicaefolia* Lamk. Detailed account on their breeding behaviour and their karyotype analysis is in progress. On the whole, it may be concluded that the tribe has several base numbers and the different species have evolved independently.

Dept. of Botany,
Patna University,
R. P. Roy.
R. P. SINHA.
Patna, August 23, 1960.

1. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, Allen & Unwin, London, 1955.
2. Davie, J. H., *J. Genet.*, 1933, 28, 33.
3. Skovsted, A., *Ibid.*, 1935, 31, 263.
4. —, *C.R. Lab. Carls. S. Physiol.*, 1941, 23, 195.
5. Winge, O., *C.R. Trav. Lab. Carlsberg*, 1917, 13, 131.

CUP LEAF—A NEW LEAF MUTANT IN RAI (*BRASSICA JUNCEA* COSS)

A MUTANT, designated cup leaf because the upper leaf surface curved into a cup-like shape due to the incurving of the margin (Fig. 1), was observed by the author in his breeding material at the Government Research Farm, Kanpur, in 1955-56. The mutant bred true in the succeeding generations. To study its inheritance it was crossed with a normal type, Laha 101. The F₁ gave an intermediate expression,

The F_2 population segregated into normal, intermediate and cup leaf plants. While noting segregation some difficulty was, however, felt in classifying the plants into normal and intermediate classes but the differences between the intermediate class and the cup leaf plants were quite marked. The population was, therefore, classified into two groups, viz., Normal and Cup leaf. There were 1,300 normal and 254 cup leaf plants in F_2 . This gives a ratio of about 5.1 normal : 1 cup leaf. The observed ratio does not fit to any of the ratios expected on the basis of a monogenic or digenic segregation.



FIG. 1. Showing the cup leaf character in *rai*.

The ratio of about 5.1 normal : 1 cup leaf observed in F_2 above fits in very closely to a 54 normal : 10 cup leaf ratio to be expected on the basis of trigenic segregation (Chi-square 0.612 P. value between 8.50 and 0.30). This indicates an interaction of 3 genes. If, for the sake of simplicity, the genes for cup leaf characters are termed as recessive, then the presence of at least 2 recessive genes will be necessary to produce a cup leaf character. This explanation seems to be probable and is supported by the F_3 studies.

All the F_3 progenies of selected cup leaf F_2 plants bred true. Of the 9 F_3 families of the plants selected from the normal class, five progenies from F_2 plants with absolutely normal type leaf bred true while the remaining 4 pro-

genies segregated into normal and cup leaf plants as follows :—

TABLE I
Segregation of F_3 families

Families	Segregation			Remarks
	Normal	Cup leaf	Total	
1	27	21	48	9 : 7 (Chi-square 0.0)
2	225	37	262	54 : 10 (Chi-square 0.444 P. between 0.70 and 0.50)
3	267	52	319	54 : 10 (Chi-square 0.110 P. between 0.30 and 0.70)
4	56	4	60	15 : 1 (Chi-square 0.182 P. between 0.70 and 0.50)

Thus two progenies segregated into a 54 : 10 ratio, one segregated into 9 N : 7 C and one into 15 N : 1 C ratio. The population in families one and four is rather small. In family 1 the segregation into a 9 : 7 ratio is unusually quite perfect while other families also give a very close fit to the expected ratio. These results support the trigenic segregation of the normal and cup leaf characters. The number of F_3 segregating families is, however, very small and for further confirmation of these results a more intensive study will be made.

The mutant has also been observed to have relatively less shattering pods. This character may prove to be of economic importance in breeding varieties resistant to shattering.

Regional Res. Centre DHARAMPAL SINGH.
(Oilseeds and Millets),
I.C.A.R., Pircom,
Kanpur, September 3, 1960.

FURTHER REPORT ON THE PEBRINE GERM OF *PHILOSAMIA RICINI* HUTT. AND ITS INFECTIVE CAPACITY ON *BOMBYX MORI* LINN.

Nosema bombycis Naegeli is the causative organism of pebrine disease of *Bombyx mori* Linn., the detailed life-cycle of which has been described by Stempell (1909).

Jameson (1922) has made the statement that '*Nosema bombycis* is a parasite of the eri worm' too. It is also popularly presumed that the germ of *P. ricini* Hutt. has a disastrous effect on *B. mori* Linn., so that rearing both the races in the same room is not considered advisable.

Steinhaus (1949) notes that cross-infections are relatively rare unless one deals with animals coming in the same minor taxonomic category (e.g., genus) or in closely related categories. *B. mori* and *P. ricini* do not come under the same genus and, in fact, not even the same

family. So, the problem of cross-infection was taken up for investigation.

A local multivoltine, the *Moria* and an imported univoltine, the *Chinese White* breed of *B. mori*, were used in the experiment. Mother moths from both *B. mori* and *P. ricini* were examined carefully for freedom from pebrine and disease-free eggs were used in the experiment. Pebrine germs of *P. ricini* were obtained from diseased moths and fed to the larvae of *B. mori* of different ages by smearing the crushed material of diseased moths on leaves. Larvae of healthy *P. ricini* were also similarly fed with the same diseased moth material. The number of feedings with the diseased material varied from one to ten in each group. The progeny of the *Moria* breed, which were given the maximum number of disease meals, were also reared for four generations continuously and in each generation two meals of diseased material were given. Specimens were examined by the smear method.

Larval or pupal mortality of *B. mori* was noticed in the first experiment, but in all the trials, examination under microscope revealed only bacterial infection and pebrine spores were not found either in dead or live specimens of *B. mori*. On the other hand, the group of *P. ricini* which received pebrine meal succumbed to the disease or the survivors revealed heavy infection. Typical pathogenic characters recorded by Talukdar (1960) could also be seen in this group. Groups of *P. ricini* which were not given a pebrine meal remained healthy.

Jameson (1922) found by experiment that the virulence of the disease in the case of *B. mori* increases from generation to generation. This holds good in the case of *P. ricini* infection according to our observations. But *Moria* breed of *B. mori* fed with pebrine germ of *P. ricini* repeatedly for four generations did not show signs of the disease.

The size of the pebrine spores of *P. ricini* is also different from that of *B. mori*. It generally ranges from $3.2\text{ }\mu$ to $4.6\text{ }\mu$ in length by $1.5\text{ }\mu$ to $2.1\text{ }\mu$ in width in the case of *P. ricini*, while the size of *N. bombycis* is given by Kudo (1946) as 3 to $4\text{ }\mu$ by 1.5 to $2\text{ }\mu$.

The above results lead to the conclusion that the pebrine germ of *P. ricini* cannot infect *B. mori*.

If Jameson's (1922) statement is correct, the germ of *P. ricini* fed to *B. mori* would have developed the same disease in *B. mori* also. The present results lend support to the author's (1960) inference that the pebrine germ of *P. ricini* might be different from that of *B. mori*.

Regional Sericultural Research Station,
Titabar (Assam), September 9, 1960.

1. Stempell, W., *Arch. Protistenk.*, 1909, **16**, 281 (original not seen).
2. Jameson, A. P., *Report on the Diseases of Silkworm in India*, Superintendent, Government Printing, India, Calcutta, 1922, 28, 85.
3. Steinhaus, E. A., *Principles of Insect Pathology*, 1949 (First edition), McGraw-Hill Publication, p. 191.
4. Talukdar, J. N., *Sci. and Cult.*, 1960, **26**, 81.
5. Kudo, R. R., *Protozoology*, 1946, Charles C. Thomas, Springfield, Ill.

PRELIMINARY TRIALS WITH AN ENTOMOGENOUS BACTERIUM, *BACILLUS THURINGIENSIS* BERL., NEW TO INDIA

SINCE the successful control of Japanese beetle in U.S.A. by microbial means, entomogenous spore-forming bacteria have received much attention on account of their great potentialities for insect control.¹ Of the several organisms studied none probably has offered as much promise as has the crystalligerous spore-forming bacterium, *Bacillus thuringiensis* Berl., which is effective against a wide range of destructive caterpillar pests in many countries.²

With a view to studying the action of *B. thuringiensis* on the common insect pests affecting cultivated crops in India a culture of the bacterium was brought from U.S.A., and preliminary trials were started in Agricultural College and Research Institute, Vellayani, Kerala State. Results of both laboratory and field trials have revealed that the caterpillars of *Plusia peponis*, *Margaronia indica* and *Glyphodes* sp., were highly susceptible in all stages of growth. In many cases cent per cent. mortality was observed within 24 to 48 hours. Though the early stages of *Nephantis serinopa* and *Spodoptera mauritia* were susceptible, the older larvae showed some resistance. In all these cases typical symptoms of death due to bacterial infection were noticed. The bacterium was cultured from the dead insects and the identity was confirmed both by morphological features and pathogenicity tests. The bacterium had no deleterious effect on the honey-bees. Some of the common parasites and predators like *Trichospilus pupivora*, *Apanteles* sp., *Microbracon* sp., *Scymnus* sp., were not affected by the bacterium under laboratory and field conditions.

Large-scale field trials using this bacterium are in progress.

Entomology Department,
Agricultural College and
Research Institute,
Vellayani, Nemom P.O.,
October 22, 1960.

G. RENGA AYYAR.

1. Steinhaus, E. A., *Ann. Rev. Microbiol.*, 1957, **11**, 165.
2. Tanada, Y., *Ann. Rev. Ento.*, 1959, **4**, 277.

CODEINE PHOSPHATE AS A PRETREATING AGENT

CODEINE phosphate, a phosphate derivative of the plant alkaloid codeine (extracted from the unripe heads of poppy), was tried as a pretreating agent.

The root tips of *Pisum sativum* Linn. (BR. 2) were dipped for $2\frac{1}{2}$ hours in 0.2% aqueous solution of codeine phosphate, at room temperature (27°C .). The tips were then transferred to 1 : 3 acetic alcohol and permanent preparations were made following the usual acetocarmine squash method. Heating was avoided and mounting was done in Euparol. Camera lucida drawings of the various stages of mitosis were taken from the permanent slides.

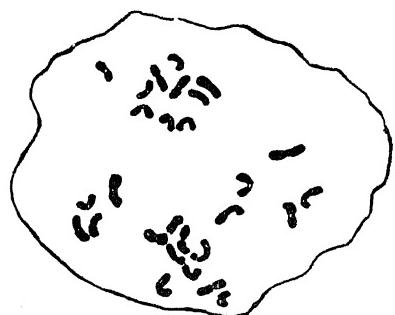


FIG. 1.

FIG. 1. Camera lucida drawing of early anaphase showing twenty-eight chromosomes.

As shown in the figure, the effects of this pretreating agent has been (1) the disorganisation of the spindle; (2) the contraction of the chromosomes; (3) the clarification of the primary constrictions and (4) the adequate separation of the chromosomes.

It would appear, therefore, that this chemical can be used instead of paradichlorobenzene, coumarine, 8-oxyquinoline, etc.

The authors wish to thank the Director, I.A.R.I., for kindly sending the seeds and the Head of the Department of Botany of L.S. College for providing the necessary facilities.

L.S. College, AKHAURI BALRAM PRASAD.
Muzaffarpur, Bihar, UMAKANT SINHA.
September 9, 1960.

OBSERVATIONS ON STOMATA IN COLEOPTILE OF *ORYZA SATIVA* L.

DURING the course of anatomical studies, including different species of *Oryza*, in progress at the Central Rice Research Institute, observations were made on stomata in different parts of the plant. It has been found that the shape of stomata, observed on the coleoptile, presented a different appearance from that on the leaf. This has been confirmed from seedlings of a large number of rice varieties.

The guard cells of stomata on the leaf of the rice plant are dumb-bell-shaped, being bulbous at the two ends and straight in the middle (Fig. 1), whereas the guard cells of stomata

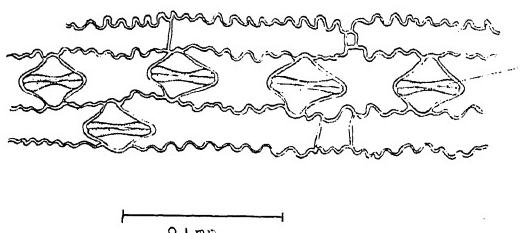


FIG. 1. Stomata in leaf of *Oryza sativa* L. showing dumb-bell-shaped guard cells; G, guard cell.

on the coleoptile are kidney-shaped (the normal type) and they continue to retain more or less the same shape throughout, till the coleoptile begins to wither away. The accessory cells in the stomata of coleoptile are not always distinct from the epidermal cells. Sometimes only one of the two accessory cells is distinct and in some cases none could be recognised (Fig. 2).

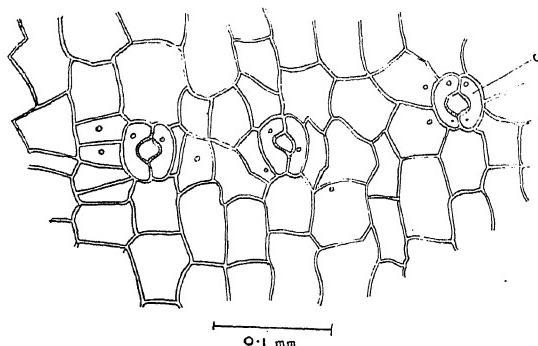


FIG. 2. Stomata in coleoptile of *Oryza sativa* L showing kidney-shaped guard cells; G, guard cell.

The dumb-bell-shaped type is characteristic of Gramineæ and Cyperaceæ, whereas the kidney-shaped type (the normal type) is characteristic of other angiosperms (Esau, 1953 and others). Marked variations in the number and size of stomata do occur, as observed by a number of

investigators, not only in the different varieties of the same species but also in the same varieties grown under different conditions. But variation in the shape or structure of the stomata on the same plant, as observed here (both dumb-bell-shaped and kidney-shaped guard cells), does not seem to have been recorded. According to Flint and Moreland (1946) and Esau (1953) working on sugarcane, the guard-mother cell divides to form two guard cells which during enlargement first become kidney-shaped and then assume their characteristic dumb-bell-shape. Kaufman (1959) working on leaf histogenesis of *Oryza sativa L.* also noted a similar developmental stage.

Central Rice Research Inst., R. H. RICHHARIA.
Cuttack-4, August 27, 1960. J. K. Roy.

1. Esau, K., *Plant Anatomy*, New York, 1953.
2. Flint, L. H. and Moreland, C. F., *Amer. J. Bot.*, 1946, 33, 80.
3. Kaufman, P. B., *Phytomorphology*, 1959, 9, 277-311.

MODIFICATION OF EJACULATORY DUCT IN *EMPOASCA DEVASTANS* DIST.

THE study of the reproductive system of jassids has been a neglected subject so far. A detailed study of the reproductive system of cotton jassid revealed some very interesting features. It was found that the ejaculatory duct in *Empoasca devastans* Dist. has a peculiar modification.

Testis (Tes) (Fig. 1).—There is a pair of testis lying in the abdominal cavity of the third

follicles which are globular in shape and open separately into the vas deferens (*Vd*) of their side by small vasa efferentia (*Ve*). The testicular follicles have spermatogonia in different stages of their development.

Vas deferens (Vd).—There is a pair of these tubular structures lying below the alimentary canal; these along with the testes are mesodermic in origin. After receiving the testes, the vasa efferentia converge backwards to open separately into the bulbous part of the ejaculatory duct, just beneath the alimentary canal. Functionally they serve as simple conduit for the spermatozoa released from the testes.

Common ejaculatory duct.—It is stated to be an unpaired tube in its embryonic stage in insects but at its anterior end it may be frequently forked specially when accessory glands arise from it (Snodgrass, 1935). In this insect it is of a very peculiar nature and consists of three parts—the anterior part is a bulbous body in which the two vasa deferentia open; the median part comprises two narrow tubes which converge posteriorly to open into the third part which is an unpaired tubular structure. It appears that the posterior unpaired tubular structure is the main body of the ejaculatory duct, and the median-paired tubes are its persistent forked ends from which the accessory glands arise nearly at the level of the posterior border of the bulbous body which might have been formed by the union of the vasa deferentia.

Accessory Glands (Ac Gl).—There is a pair of long tubular accessory glands lying lateral to the ejaculatory duct and arising from the latter, above midway.

Dept. of Agri. Zoology V. G. KHANWILKAR.
and Entomology, U. S. MISRA.
Agricultural College, M. L. PUROHIT.
Gwalior, September 19, 1960.

1. Snodgrass, R. E., *Principles of Insect Morphology*, 1935.

A NOTE ON THE CRYPTOGAMS OF BHOPAL

THE Cryptogams of Bhopal plateau and its adjacent parts are very imperfectly known. Except for a few papers which deal with the flora of the adjacent regions (Pande and Shrivastava, 1952; Bapna, 1958) this region seems to have received little attention in the past. The present note is based on collections maintained for the last few years.

The Bhopal plateau (alt. 1,800-2,000 ft.) is mostly hilly, the annual average rainfall is 30 to

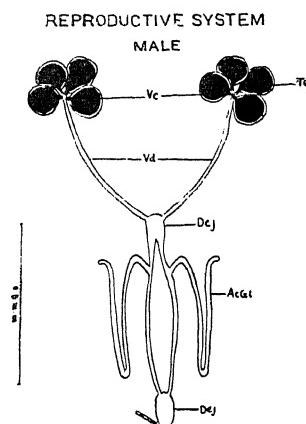


FIG 1

visible segment dorsolateral to the alimentary canal. Each testis consists of four testicular

TABLE I
Liverworts collected from Bhopal plateau

Hepaticae	Localities	Habitat	Distribution in India
Anthocerotales:			
<i>Anthoceros himalayensis</i> Kashyap (tuber forming)	Very common, Bhad-bhada and Delawari streams	In shade on clayey soil along banks	Mt. Abu, W.H., S.I., E.H.
<i>Anthoceros punctatus</i> L.	.. Common, Delawari	On gravel and moist soil	E.H. (Assam), Lucknow*
<i>Notothylas indica</i> Kashyap	.. Common	On moist ground	Pachmarhi, W.H., S.I.
Marchantiiales:			
<i>Plagiochasma intermedium</i> L. et G.	do.	On moist dilapidated walls	do. (Pathankote)
<i>Asterella angusta</i> (St.) Kachroo	Very common	On moist clayey soil on bank of streams	do. E.H., Mt. Abu
<i>Cyathodium baroda</i> Chavan	.. do.	In sheltered places on walls	Mt. Abu, Pachmarhi, S.I.
<i>Riccia discolor</i> L. et L.	.. Common	On moist ground and gravel paths	Mt. Abu, Pachmarhi, S.I. W.H., E.H.
<i>R. gangetica</i> Ahmad	.. Very common	do.	do.
<i>R. billardieri</i> Mont. et N.	.. do.	do.	Mt. Abu, S.I., E.H.
<i>R. plana</i> Taylor	.. Common	do.	Mt. Abu, S.I.
<i>R. tuberculata</i> Pande et Udar	.. Very common	do.	S.I.
<i>R. melanospora</i> Kashyap	.. Common	On niches of walls in exposed places	W.H. (Punjab plains and Lucknow)
<i>R. sp.[†]</i>	.. Not common	On silt of barks of ponds	..

Abbreviations : W.H. = Western Himalayas; E.H. = Eastern Himalayas; S.I. = South India; Mt. Abu. = Mount Abu.

* See Handoo, O. N., *Curr. Sci.*, 1959, 28, 470.

† Probably *R. crystallina*. On account of scanty unfertile material no identification was possible.

TABLE II
Cryptogams collected from Bhopal plateau

Types	Localities	Habitat
Lycopodiales:		
<i>Selaginella</i> Sp.	.. Delawari forest	On moist ground in shade
Ophioglossales:		
<i>Ophioglossum fibrosum</i> Schum.	Common	Moist hilly slopes during rainy season
<i>O. vulgatum</i> L.	.. Less common	do.
<i>O. gramineum</i> Willd.	Rare	do.
<i>O. nudicaule</i> L.	.. Common	do.
Filicales:		
<i>Actinopteris dichotoma</i> Bedd.	do.	On rocks and old walls
<i>Adiantum caudatum</i> L.	do.	Slopes of hill in shade
<i>A. philippense</i> Linn. (<i>A. lunulatum</i> Burm.)	do.	do.
<i>Pteris longifolia</i> L.	.. do.	Crevices of walls and wells
<i>Cheilanthes tenuifolia</i> Sw.	do.	On hills on rocks
<i>Marsilea quadrifolia</i> L.	do.	In water, near banks of streams and ponds
<i>Azolla pinnata</i> R.Br.	Lower lake	In still freshwater

50 inches. The soil is mostly red gravel and interspersed at some areas with black cotton soil. The rocks constituting the hills are metamorphic and sandy ; and the vegetation is of mixed deciduous type.

Table I shows that out of the twelve species listed, *Anthoceros himalayensis*, *Asterella angusta*, *Riccia gangetica* and *Riccia discolor* have an all-India distribution. *Notothylas indica* comes next, though unrepresented in E.H. and Mt. Abu. Seven species are represented in the Ghats, seven in Western and six in Eastern Himalayas and ten in South India. Bhopal plateau, thus, represents a mixture of the hepatic flora from all the four corners of India.

The authors are thankful to Dr. P Kachroo for his valuable suggestions and help and also for going through this note.

Department of Botany,
Govt. Hamidia College,
Bhopal, September 26, 1960.

S. D. SAKSENA.
O. N. HANDOO.

1. Bapna, K. R., *Curr. Sci.*, 1958, 27, 259.
2. Chopra, R. S., *J. Indian bot. Soc.*, 1943, 22.
3. Pande, S. K. and Srivastava, K. P., *Ibid.*, 1952, 31 (4), 342.
4. — and Udar, R., *Proc. Nat. Inst. Sci. India*, 1958, 24, 79-88.

REVIEWS

An Introduction to Stochastic Processes. By M. S. Bartlett. (Cambridge University Press, London N.W. 1), 1960. Pp. 312. Price 22 sh. 6 d.

It is a privilege to write about the book entitled "An Introduction to Stochastic Processes" by my teacher and guide Professor Bartlett. When it appeared first in 1955, it was the only book on stochastic processes with special preference to methods and applications. The only systematic account, from a stochastic point of view, of some physical processes was perhaps the famous article by Dr. Chandrasekhar in the *Reviews of Modern Physics*. Until recently the theory of stochastic processes was treated as a close preserve of pure mathematicians who regarded it as a branch of measure theory. Doob's classic work was written in a language quite unfamiliar to physicists and even physicists acquainted with the theory of probability did not consider stochastic processes as part of mathematical physics. This seems particularly surprising since the probabilistic interpretation of quantum mechanics is as old as quantum theory itself.

The recent interest in the application of stochastic processes stemmed from three different sources.

- (1) Biology and the theory of population growth;
- (2) Cosmic ray cascades, and
- (3) the theory of turbulence and problems of correlation arising therefrom.

Even before the interest in actual applications arose, the theory of Markoff processes had reached a comparatively advanced stage; so also that of analytical operations in random processes. Hence suitable adaptations to actual physical problems came as a natural consequence to these developments. Professor Bartlett's book was written at this critical period in the development of the theory when new techniques were devised from a basic mathematical structure. His book starts with a rather conventional summary of the standard probabilistic concepts but we are rapidly led into the theory of random sequences and Markoff chains written in such lucid style that one may perhaps be led to the belief that all this is just a standard extension of the concept of an aggregate of random variables. This is erroneous if we remember that the simplest derivation of the

Furry process was made as late as 1937 in an original contribution to the *Physical Review* and Kolmogoroff wrote a fundamental paper on branching processes a few years later. The chapter on random processes in continuous time is written in a style readily acceptable to the physicist. The sections on recurrence and first passage times are perhaps some of the best in this book. Among the fields of application which stimulated new techniques of the theory are problems relating to queues, population growth and more generally, point processes. A good summary of the method of regeneration points, product densities and the use of the characteristic functional is given in the course of dealing with the problems themselves.

As regards the mathematical aspects of the book, it is quite clear that Professor Bartlett was influenced by the work of his associate Dr. Moyal who contributed a very important paper in the symposium of the Royal Statistical Society held in 1949. In a sense the proceedings of that Symposium perhaps started Professor Bartlett on the idea of writing the book. The chapter on limiting stochastic operations is mainly based on Moyal's article.

The role of statistical ideas in hydrodynamics and the importance of the spectral theory of random functions has long been realised by applied mathematicians. Though Professor Bartlett's chapter on stationary processes does not lead to the problems of turbulence, it presents a harmonic analysis in a usable form.

The chapters on communication theory serve as an introduction to a subject which is now claiming to be complete in itself. This chapter was written at about the time when Shannon's celebrated contributions were just becoming familiar.

What we have till now described refer to the probabilistic aspect of the book. There lies the problem of statistical inference in stochastic processes theory. The last chapters of the book refer to this aspect.

The titular description of the book as an "introduction" is an understatement characteristic of the inherent modesty of a great mathematician and teacher. There is no doubt the book has already set many physicists thinking of treating many dynamical processes with a random element in their structure as stochastic processes. As a physicist, I hope that the next

edition will include new applications and if possible the probabilistic interpretation of quantum mechanics. The new paper back reprint will be welcomed in countries where book-buying is yet to become a habit among young workers and scientists.

ALLADI RAMAKRISHNAN.

Introduction to Colloid Chemistry. By Karol J. Mysels. (Interscience Publishers, Inc., New York), 1959. Pp. xv + 475. Price \$ 10.00.

To colloid chemists, Prof. K. J. Mysels needs no introduction. He is not only an active worker in several fields of colloid chemistry but also a lucid writer of several text-books and popular articles in chemistry. Being the author of 'Text-book errors', he has taken very good care to avoid the common errors in his book. The book is intended for the undergraduate who wants to be introduced to the subject of colloid chemistry with the usual knowledge of physics and chemistry, and also to the industrialist who is mainly interested in the application of the knowledge to the industry. On the whole the author has achieved his objective. He has avoided to a large extent the mathematical aspect of the subject to keep up the interest of the reader and maintaining the continuity of thought without entering into the details. For the advanced student however, the book makes only a refreshing reading. A mathematical treatment of important equations, as an appendix, would have been very useful even to an advanced student. The author has employed different symbols to denote the physico-chemical quantities. This has resulted in the use of unfamiliar symbols causing some confusion to the reader. In the opinion of the reviewer, the use of the common symbols would have given the reader an added advantage, eliminating the frequent reference to the list of symbols at the end of the book.

The book has been divided into XX Chapters. Each chapter ends with the summary, references and problems connected with the chapter. The first five chapters deal with the general properties of colloids like structural elements, sedimentation rate, flocculation, diffusion and Brownian motion. The next two chapters deal with the colligative properties and sedimentation equilibrium. Chapters VIII and IX deal with sorption and its application to a variety of phenomena like protective action, sensitisation, chromatography, etc., involving the process of sorption. Fluctuations and rubber

elasticity, preparation of colloids and rheology form the subject-matter of Chapters X-XII. Nearly hundred pages are devoted in dealing with the electrical properties of colloids under the headings: electroneutrality, the double layer, electrokinetics and charge effects in colloids. The optical properties are dealt with in the last three chapters where refraction, schlieren, interference, and scattering by colloids are discussed.

In many respects, the author has struck a new and well-thought-out plan in the arrangement and presentation of the subject-matter. The book is a valuable guide both for the teachers and the students in the colleges in understanding the principles of colloid chemistry.

M. R. A.

Fast Neutron Physics—Part I. Edited by J. B. Marion and J. L. Fowler. (Interscience Publishers, Inc., New York), 1960. Pp. 983. Price \$ 29.00.

This publication styled as Part I contains 24 contributed articles which have been grouped under four sections: (1) Neutron Sources; (2) Recoil Detection Methods; (3) Detection by Neutron-Induced Methods and (4) Special Techniques and Problems.

The discovery of the fission enhanced the importance of neutrons tremendously and modern atomic reactors based on neutron multiplication compete with any other source of power in meeting world's energy needs. The neutrons that we meet with in this field are slow neutrons, about which much has been written. The present volume, however, concerns itself with fast neutrons falling in the range between 1 KeV neutron energy to several hundred MeV.

The four sections comprising Part I are concerned with experimental techniques. The first section discusses neutron sources, both radioactive sources and those resulting from bombardment with artificially accelerated particles. Sections II and III are concerned with neutron detection by recoil methods and by neutron-induced reactions respectively. In Section IV are a number of papers on special techniques and problems such as time of flight techniques, flux measurements, target preparations, neutron shielding both for experimental as well as radiation protection purposes, electronic computer methods and general health physics problems when handling neutrons.

The volume is meant to be a reference work and will be of interest and use not only to

research scientists, but also to reactor engineers and health physicists.

A. J.

The Chemistry of Natural Products. Edited by K. W. Bentley. Vol. V. *The Carbohydrates*. By S. F. Dyke. (Interscience Publishers, New York, London), 1960. Pp. 232. Price \$ 4.75.

As a text on the constitution of carbohydrates, the book offers quite brief and succinct reading in parts with relevant information well emphasised. But the paucity of information in many essential sections of the book tempts one to wonder if the book as a whole would be of much use to any student appearing for an examination on a fairly advanced level, for instance, the M.Sc. students of Indian Universities. This criticism may be elaborated by the following examples:

In a discussion on the methods of chain-lengthening of aldoses (p. 18) there is no written explanation of the formulæ to which reference is made in the text.

"Sowden method (12). This is illustrated in XXXIX to XLII.

Ruff method. This is one of the most useful methods (XLVII to XLVIII).

MacDonald-Fischer method (8). This is very useful in many cases (XLIX to LI).

.....
Addition of one carbon atom (LV to LIX)." While numerous pages are left blank in the book elsewhere, the brevity achieved in the instances described above is meaningless. With better planning, the experimental conditions, reagents and other details could be mentioned and explained in greater detail. The discussion on Hudson's isorotation rules does not present even a single illustration for the rules propounded. The definition of Molecular rotation though technically correct is different from what is mentioned in most other text-books and monographs. Mention should have been made of this difference.

The section on derivatives of the monosaccharides is well listed with the usual derivatives like the methyl, benzyl, trityl ethers, isopropylidene derivatives and phosphates. The preparation and properties of these compounds are described. However, under the heading Sulphates (p. 78) there is a void!

There are numerous other trivial mistakes like the erroneous formula on p. 9. But the criticisms levelled against the volume under review stem mainly from two considerations. That these would help the editor in preparing

a better volume in the series on other topics yet to come. Secondly, a more necessary consideration, in so far as Indian students are concerned, a complete text-book like that of the Fiesers' on Organic Chemistry incorporating most of what this monograph dishes out, is available for much nearly the same price.

B. S. T.

The Plasma Proteins, Vol. I. Edited by F. W. Putnam. (Academic Press, New York and London, India: Asia Publishing House, Bombay-1), 1960. Pp. xv + 420. Price \$ 12.50.

The book under review, which is the first of two volumes on Plasma Proteins edited by F. W. Putnam, deals with the isolation, characterization and function of an important class of proteins found in the plasma. It gives an authoritative account of the different aspects of plasma proteins which at present is found scattered in different research publications. The introductory chapter written by the editor himself gives a bird's eye view of the contents of this volume and is followed by an article of R. B. Pennell dealing with the fractionation and isolation of the various components by means of precipitation methods. The latter also includes a section giving brief account of the theoretical principles involved in the adoption of such procedures. Special emphasis has been placed on low temperature fractionation by thanole so widely adopted after its first application by E. J. Cohn and there is also a well compiled set of appendices, summarizing the data obtained by standard methods.

Analytical and preparative electrophoresis of human serum proteins is presented by G. R. Cooper and this is again highlighted by a comprehensive tabulated statement bringing together in one place all the electrophoretic and ultracentrifugal data on this subject. E. A. Peterson and H. A. Sober have dealt with the chromatography of plasma proteins in the next article with particular reference to the column chromatographic technique. A table containing specific procedures along with critical comments has also been included at the end of this chapter.

The amino-acid composition of several of the important plasma proteins, the known data on the terminal amino-acid sequences of albumins and an exhaustive compilation of molecular parameters such as electrophoretic mobility, molecular weights and sedimentation constants have been included in the next article by R. A. Phelps and F. W. Putnam. Exhaustive

accounts on plasma albumin as well as on gamma globulin and antibodies have been presented by J. F. Foster and R. R. Porter, respectively, in the subsequent chapters, while H. G. Kunkel in a later article has dealt with the immunochemical and ultracentrifugal aspects of macroglobulins and antibodies of high molecular weight. R. J. Winzler—wrongly spelt as R. H. Winzler in the list of contributors as well as in the table of contents—has given an excellent account of glycoproteins covering the extensive literature and has included a table giving all available data on the subject. The last chapter on metal binding plasma proteins and cation transport by C. B. Laurell deals with the interaction of metal ions like iron, copper and zinc with plasma proteins. It contains, in addition, methods of isolating them and a discussion of their biological significance.

As F. W. Putnam has stated in his introduction, "much is to be expected in the way of discoveries in the plasma proteins in coming years", and "one aim of this book is to stimulate exploration by charting the developing areas and directing attention to the vast unknown". The present volume has served the above purpose exceedingly well and all readers interested in this subject will look forward with eagerness to the early publication of the second volume dealing with the biosynthesis, metabolism and alterations in disease, of plasma proteins.

P. S. SARMA.

Current Bibliography for Aquatic Sciences and Fisheries, Vol. 3, Part 1. Compiled by F.A.O. Fisheries Biology Branch. (Published by Taylor and Francis Ltd., London, E.C. 4). Price for Part £ 0-17-6; Volume of 12 Parts £ 9-0-0.

This volume, the first printed one, is a continuation of Vols. I and II of the series issued in mimeographed form during 1958 and 1959 and is a very valuable asset to workers in the disciplines of aquatic biology and fisheries. Nearly half of this part is taken up with an explanation of the coverage and arrangement, consolidating the "Explanatory Notes" issued time to time in the earlier versions of the Bibliography. What strikes an Indian reader foremost is the almost total absence of coverage of Journals and papers published in India and in the South-East Asia region in general. Only the *Indian Journal of Fisheries* and 8 papers published therein find a place among about 628 papers listed! Quite a large number of relevant papers in the disciplines concerned are to be found in other Journals such as: *Proc. Ind.*

Acad. Sci., B., J. Indian bot. Soc., Curr. Sci., Proc. Nat. Inst. Sci. India, etc. It is hoped that this lacuna will be filled up. Regarding the arrangement of references, an alphabetical order would have been better and more useful as they have not been placed under different heads. However, these remarks are not to detract the importance of the work. The publishers deserve all thanks for bringing this Bibliography out. The price will be found to be too prohibitive by individual workers.

R. SUBRAHMANYAN.

Geology of India and Burma. By M. S. Krishnan, IV Edition. [Higginbothams (Pt.) Ltd., Mount Road, Madras], 1960. Pp. 604. Price Rs. 22-50.

It is a pleasure to see the Fourth Edition of this book brought out so soon after the publication of the third Edition in 1956. The book has been divided into 20 chapters. The first chapter deals essentially with the major Geological and Geographical features of the Indian Continent. The second chapter gives a concise account of the structures and the major tectonic features of India. The main orogenic belts have been described and the entire thing is incorporated in a neat sketch. The third chapter deals with the principles of Indian stratigraphy, their equivalents in standard stratigraphical scale and certain major stratigraphical peculiarities in India.

Three chapters 4, 5 and 6 are devoted to the Archæans of India, 4th dealing comprehensively with the Archæan of Peninsular India in which an excellent summary of the work of the Geological Surveys has been incorporated, indicating the main problems of Archæan geology. The fifth chapter deals with the Archæan of extra-Peninsular India. A separate chapter deals with the economic importance of the Archæan rocks giving a summary of the most important mineral deposits found in these rocks.

The remaining fourteen chapters are devoted to the various systems, each chapter dealing with one of the systems. In dealing with the stratigraphy of each of the systems, at the beginning, their European equivalents are given which will at once make their positions very clear to the students.

A large number of maps, sketches and sections have been included which enhances the value of the book not only to the advanced students of Indian Geology, but also to the Research workers. A welcome change from the previous edition is the inclusion of the Geological Map of India in black and white in

four different parts. It would have been ideal if the attempts of the author to include a coloured Geological Map of India in one sheet had materialised.

This book represents a summary of the great discoveries made in Indian Geology during the last one hundred years, and as such has become an invaluable guide to all Research workers in the field of Indian Geology. Coming as it does from the authoritative pen of the distinguished author it must readily find a place in all University libraries. The cost has been kept fairly low, and both the author and the publishers must be warmly congratulated on this excellent production.

M. R. S.

Monographs for Teachers : No. 1—Principles of Electrolysis. By C. W. Davies. Pp. 30, Price 3 sh. 6 d.; No. 2—*Principles of Oxidation and Reduction*. By A. G. Sharpe. Pp. 30, Price 3 sh. 6 d.; No. 3—*Principles of the Extraction of Metals*. By D. J. G. Ives. Pp. 57, Price 6 sh.; (The Royal Institute of Chemistry, 30, Russell Square, London W.C. 1).

Index of Chemistry Films. (The Royal Institute of Chemistry, London W.C. 1), 1959. Pp. ix+150. Price 5 sh.

The developments that have taken place in the different branches of science during the last two decades or so, have been so rapid that it is the experience of teachers who teach the subject at a more advanced level, that his students will have to "unlearn" a good deal of what he had been taught at a more elementary stage. Especially is this so in chemistry. In this context it is an extremely useful venture that the Council of the Royal Institute of Chemistry has undertaken to issue "concise and authoritative accounts of selected well-defined topics in chemistry" for the guidance of the teachers of the subject in High School classes. The *Monographs for Teachers* written by experienced Professors and Readers attached to University Colleges will be greatly welcomed by all science masters. Advanced students also will find in these booklets much that will be of value to them.

Another publication by the Royal Institute of Chemistry (*viz.*) the *Index of Chemistry Films* aims to bring together in one volume relevant details concerning 800 films and 200 filmstrips. These cover the requirements of schools, technical colleges and training departments of industrial firms. The list includes a

variety of instructional films ranging from the elementary to the research type.

Proceedings of the Symposium on Thyro-Gonad-Adrenal-Pituitary Relationships Held at New Delhi in 1959. (*Bulletin of the National Institute of Sciences of India, New Delhi*, No. 17), March 1960. Pp. xi + 131. Price Rs. 10.62 n.P.

The interrelationships between endocrine glands and their regulatory mechanisms are still fields of experimentation. While broad generalizations on the role of endocrine secretions in the maintenance of homeostasis can be made, there are many intricate and vexed problems which still defy solution. With the advances in methodology and the application of newer biochemical and histological techniques including radioactive tracer studies, it has been possible to unravel certain metabolic and functional aspects of some hormones.

The proceedings of the symposia highlight the present state of our knowledge pertaining to interrelationships existing between the thyroid, gonad, adrenal and pituitary hormones. The subjects discussed cover a wide area of biological interest. The influence of those hormones on reproductive physiology, the enzymatic activities of some hormones, the hormonal regulation mechanisms as affected by clinical disorders, and the use of tracer technique for evaluation of function and interrelationship of thyroid with the gonads and pituitary are a few of the many interesting topics presented in this volume.

M. SIRSI.

Biennial Review of Anthropology 1960. Edited by Berhard J. Seigel. (Stanford University Press, California), 1959. Pp. x + 273. Price \$ 6.00.

Participating in the discussions during the Wenner-Gren Foundation Symposium on Anthropology in the summer of 1952, Nadel focussed attention on the fact that the literature available to an anthropologist was growing so fast that no single person could hope to master it even in his own field of research. Therefore, he pleaded: "We need a book that, year by year, will summarize the ethnographic work that has been carried out—the mere factual material, the theoretical advances made or our hypotheses, and the conclusions that have been suggested" (*An Appraisal of Anthropology Today*, edited by Sol Tax et al., 1953, pp. 89-95). The Wenner-Gren Foundation issued a Yearbook of Anthropology in 1955, a bulky volume of about 850

pages containing original papers. The Editor of the book under review explains that this is the first volume of a separate series which will appear at short intervals. "It is intended to describe and summarize in a systematic manner the more noteworthy papers and monographs published since 1955 in five fields of major current interest; social and cultural change, physical anthropology, linguistics, social organization, and psychological dimensions of culture" (p. v). This Review, we believe, more than the Yearbook issued by the Wenner-Gren Foundation in 1955 meets the kind of demand Nadel and numerous other anthropologists have felt in recent years.

The book consists of seven chapters :

(1) Recent Advances in Physical Anthropology (G. W. Lasker); (2) Culture Change (Louise, S. and George D. Spindler); (3) Psychocultural Studies (J. J. Honigmann); (4) Social Organizations (Harry Basehart); (5) Recent Trends in Soviet Anthropology (Lawrence Krader); (6) Language (Floyd Lounsbury), and (7) Political Anthropology (David Easton).

The coverage of published materials is extensive. Thus Lasker lists 412 publications of the years 1955-57 covering over a dozen subjects including the process of human evolution, primatology, race, blood groups, abnormal haemoglobin, dermatoglyphics, taste sensitivity, growth, chemical anthropology and blood-pressure. Other contributors have also similarly covered the research publications within their respective fields. But whereas some of the contributions read like bibliographies or guides to reading, others are more substantial and provide the reader a good idea of trends not only in the titles of books and papers but also in the contents and methods of research. Examples of the latter type of paper are provided by Basehart's and Easton's essays. The Editor tells us that Easton is not a professional anthropologist but a political scientist. This is all the more the reason why we must make particular mention of his excellent paper which is a discussion and not an annotated inventory. He cites only 25 references but concludes his paper by giving brief summaries of about 40 publications which are arranged in groups.

The book under review is a handy and very useful volume. We have only one criticism to offer and also two suggestions to make. The method, adopted in this book, of mentioning full particulars of the journals in which the papers cited have appeared [e.g., Beattie, J. H. M., *Africa*, 26 : 265-76 (1956)] without giving the title of the paper is very unsatisfactory. We

suggest that future issues of the *Biennial Review* should change this style of reference. Care should also be taken—and this is our second suggestion—to impress upon the contributors that what the readers will appreciate will be discussions of trends in research rather than mere inventories, no matter how comprehensive.

In the end we warmly recommend this book to all interested readers, particularly the professional anthropologists who will find it very valuable.

T. N. MADAN.

ISI Handbook of Quantities, Conversion Factors, Formulae and Tables. (Indian Standards Institution, 9, Mathura Road, New Delhi-1), 1960. Pp. 163. Price Rs. 7.50 n.P.

The Indian Standards Institution had taken upon itself the task of bringing out a Handbook which will be useful to the student population of India at this time when the country is switching over from the age-old multi-form systems of weights and measures to the uniform metric system approved by an act of parliament. The fulfilment of this task has been quite laudable.

The Handbook is divided into three sections, (A) Quantities, Units and Conversion Factors, (B) Physical and Chemical Constants and (C) Mathematical Formulae and Tables.

Section A contains a wealth of definitions and data on physical quantities in Mechanics, Heat, Light, Sound, Electricity, Magnetism, etc. Section B contains a large number of Tables on Astronomical and Geodetic data; Properties of elements, gases, liquids and solids; data pertaining to structural engineering, aeronautics and telecommunication, etc. Section C contains useful formulæ in Algebra, Trigonometry (Plane and Spherical), Geometry and Calculus. There are also the usual Tables of logarithms, squares, cubes, square-roots, reciprocals, etc., trigonometrical functions; exponential and hyperbolic functions and normal probability integrals.

This comprehensive book of constants, formulæ and tables should prove useful to all students of science, engineering and technology and in fact it should be in the pocket of every student belonging to these disciplines, but from the price it seems that the pocket has to be emptied first before making room for the book.

Books Received

The Chemical Society Annual Report on the Progress of Chemistry, Vol. LVI, for 1959. (The Chemical Society, Burlington House, London W. 1), 1960. Pp. vi + 476. Price £ 2.

Periodicals in the Chemical Society Library.
(The Chemical Society, Burlington House,
London W. 1), 1960. Pp. 48. Price 5 sh.

Pure Mathematics, Vol. I: *Calculus*; Vol. II: *Algebra, Trigonometry and Co-ordinate Geometry*. By F. Gerrish. (Cambridge University Press, London N.D. 1), 1960. Pp. xxv + 361; Pp. xxi + 363-758. Price 25 sh., 35 sh. respectively.

Indian Essential Oils—A Review. By A. K. Menon. (Council of Scientific and Industrial Research, New Delhi-1), 1960. Pp. 89. Price Rs. 7.

Discovery Reports, Vol. XXX: *Studies on Physalis (L.)*. Part I: *Natural History and Morphology*. By A. K. Totton; Part II: *Behaviour and Histology*. By G. O. Mackie. (Cambridge University Press, London N.W. 1), 1960. Pp. 301-408. Plates VII-XXVIII. Price 70 sh.

Progress in Inorganic Chemistry, Vol. 2. Edited by F. Albert Cotton. (Interscience Publishers, New York-1), 1960. Pp. 399. Price \$ 10.50.

Metabolic Pathways. Edited by David M. Greenberg. (Academic Press, New York-1), 1960. Pp. xv + 572. Price \$ 18.00.

Organic Analysis, Vol. 4. Edited by J. Mitchell, Jr., I. M. Kolthoff, E. S. Proskauer, A. Weissberger. (Interscience Publishers, New York-1), 1960. Pp. vii + 429. Price \$ 13.50.

Comparative Biochemistry—A Comprehensive Treatise, Vol. I: *Source of Free Energy*. Edited by Marcel Florkin and Howard S. Mason. (Academic Press, New York-1), 1960. Pp. xxv + 590. Price \$ 18.00.

Industrial Electric Furnaces and Appliances (Second Edition, Revised and Enlarged). By P. V. Paschkis and John Persson. (Interscience Publishers, New York-1), 1960. Pp. xvi + 607. Price \$ 24.00.

Infra-Red Methods—Principles and Applications. By G. K. T. Conn and D. G. Avery. (Academic Press, New York-1), 1960. Pp. viii + 203. Price \$ 6.80.

General Zoological Microtechniques. By Frances M. Weesner. (The Williams and Wilkins Co., Baltimore-2, Maryland, U.S.A.), 1960. Pp. xi + 230. Price \$ 5.25.

Space Trajectories—A Symposium Sponsored by the American Astronomical Society. Edited by the Technical Staff of the Radiation Inc. (Academic Press, New York-1), 1960. Pp. x + 298. Price \$ 12.00.

SCIENCE NOTES AND NEWS

Use of 'Reproduction Paper' for Printing Chromatogram

Sri. M. V. Dabholkar, French Institute, Pondicherry, writes: In the Ammonia paper method recommended by Idelman and Seshadri (*Curr. Sci.*, 1960, 29, 21), for the preparation of permanent record of chromatogram, the printing of the chromatogram should be done before the colours of the bands fade away. This is not possible when one is in need of many copies of chromatogram. In that case the use of Ammonia paper is not feasible. If, however, instead of Ammonia paper, the "Reproduction paper" (supplied by Kilburns and Co.) is utilized for printing the first copy of the chromatogram, the above difficulty would be solved. This print serves as the original chromatogram from which one can take as many copies as one wants and when needed.

It is, therefore, advisable to take the first print on the 'Reproduction paper' and subsequent copies on Ammonia paper by using the above print.

Solar High Voltage Electricity Generator

Sri. S. Parameswaran, Chartered Engineer, Bombay, writes: An easy and cheap method of generating electricity in large amounts making use of Solar Radiation has been developed and is being put to exacting tests. The heat generated by concentrating the Solar Radiation is utilized to vapourize water contained in a spherical chamber into steam. This chamber is held by two supports in such a way that it can rotate freely of its own accord due to the torque developed by the escape of steam through the two narrow outlets provided diametrically opposite. This torque is transferred to the armature of a High Voltage Alternator, generating electricity. The method which is found to be encouraging involves only simple techniques and can be installed in any open locality availing of the sun's radiation there.

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Sri. J. Sobhamadri for his

thesis entitled "Calculations from Dipole Moments of Some Halides of Group V Elements and Studies from Microwave Measurements on Relaxation Times" and D.Sc. Degree in Pharmacy to Sri. K. Sambamurty for his thesis entitled "Chemical Investigation of Some Medicinal and Poisonous Plants of India".

Calcutta University has awarded the D.Sc. Degree in Botany to Mrs. Archana Sharma for her thesis entitled "Structure and Behaviour of Plant Chromosomes in Relation to Speciation, Differentiation and Chemical Treatment" and the D.Phil. Degree in Botany to Sri. Arya Kumar Bal for his thesis entitled "Chromosomes Susceptibility to Different Compounds".

Punjab University has awarded the Ph.D. Degree in Physics to Sri. B. D. Sharma for his thesis entitled "Studies of Some Structure Sensitive Characteristics of Solids (Metals and Alloys) using Recent Optical Techniques", and Ph.D. Degree in Botany to Sri. M. L. Banerji for his thesis entitled "Contribution to the Flora of East Nepal".

Raman Chair in Physics in the Madras University

The Madras University has decided to institute a professorship—the Raman Professorship of Physical Sciences—as a tribute to the great work that Sir C. V. Raman has been doing. This was announced by Sir A. Lakshmanaswamy Mudaliar, Vice-Chancellor of the University of Madras, on the occasion of the Twenty-sixth Annual Meeting of the Indian Academy of Sciences held under the auspices of the Madras University, which he inaugurated on December 27, 1960.

Lady Tata Memorial Trust Scientific Research Scholarships

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1961-62 commencing from 1st July 1961. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognised University. The scholarships are tenable in India only and the holders must undertake to work wholetime under the direction of a scientist of standing in a recognised research institute or Laboratory on a subject of scientific investigation that must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must conform to the instructions drawn up by the Trust and should reach by March 15, 1961. Candidates can obtain these instructions and other information they desire,

from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

The Institute of Physics and Physical Society Awards

The Council of the Institute of Physics and the Physical Society has made the following Awards : The Duddell Medal to Dr. J. B. Adams, the Director-General of C.E.R.N. (the European Organization for Nuclear Research). The Charles Vernon Boys Prize to Professor A. W. Merrison of the University of Liverpool for his distinguished research in experimental physics. The Charles Chree Medal and Prize to Dr. S. E. Forbush of The Carnegie Institution of Washington for his distinguished work on the cosmic radiation.

British Industrial Biological Research Association

A new research organisation—the British Industrial Biological Research Association—has been formed to study the possible effects upon health and to ensure the harmlessness of substances which may be ingested in food, drink and cosmetics.

The Association's main object is the establishment of a biological research station for investigating the effect of the many substances used in food manufacture, either as processing aids or for flavouring and colouring food as well as those which may get into food from pesticides, from plant used in food manufacture, from packaging materials, or from utensils. Although some of the larger companies in the food and chemical industries have their own research facilities, until now there has been no national industrial organisation in this country with responsibility for work of this kind.

There is a lack of data on the effect of these substances on health, particularly when they are ingested in small quantities over a long period of time. Further development of test methods using experimental animals is also needed. Results related to research in other establishments throughout the world will be studied and interpreted for members as part of an advisory and information service.

The temporary headquarters of the British Industrial Biological Research Association Ltd., are at 11, Green Street, London W. 1.

Symposium on Indigenous Drugs

Under the joint auspices of the Indian Pharmaceutical Association (Maharashtra State Branch), the Indian Medical Association (Bombay Territorial Branch) and the Bombay Medical

Union, a Symposium on Indigenous Drugs will be held on Sunday, the 26th February 1961, in Bombay, to focus the attention of the medical practitioners and pharmaceutical chemists on some promising vegetable drugs which could come into wider use. Eminent pharmacologists and clinicians connected with researches on indigenous drugs will be participating in the symposium.

Symposium on Ecological Problems in Tropics

A Symposium on "Ecological Problems in Tropics" will be held during the Annual Session of the National Academy of Sciences at Allahabad on 3rd and 4th February 1961. Abstracts of papers (about 200 words) should be sent to the Convener, Dr. G. S. Puri, Director, Central Botanical Laboratory, Allahabad.

Atmospheric Pollution—Smog Law in California

With the passage of the Auto Smog Law on 5th April 1960, California became the first State to take legislation measures against pollution of the atmosphere by the automobile. The Bill, which became effective in July, requires control devices on all new cars throughout the State. The devices are estimated to be capable of reducing the emission of hydrocarbons and oxides of nitrogen from the automobiles by 90% and emissions of carbon monoxide by 70%. A control measure prohibiting the sale for motor fuel of gasoline having a Bromine number of more than 30 is expected to reduce the amount of eye-irritation experienced by residents of the Los Angeles Basin.—(Bull. Amer. Met. Soc., 1960, 41, 574).

High Resolution Raman Spectroscopy of Gases

Stoicheff, Rao and Turner have reported (Can. J. Phys., 1960, 38, 1516) the results of analysis of the pure rotational Raman spectra of gaseous Zinc-, Cadmium-, and Mercury-dimethyl molecules, and of their fully deuterated compounds, photographed in the second order of a 21-ft. grating with a reciprocal linear dispersion of $6.7 \text{ cm}^{-1}/\text{mm}$. The spectra are typical of symmetric top molecules and consist of many evenly spaced rotational lines having a separation of about 0.45 cm^{-1} . This is consistent with the linear C-metal-C structure. From the rotational constants of the analyses the following metal-carbon bond lengths have been obtained: Zn-C = 1.929 \AA , Cd-C = 2.112 \AA , and Hg-C = 2.094 \AA .

About 50-60 rotational lines have been measured in each of the six rotational spectra which extend to only about 30 to 40 cm^{-1} from the exciting line Hg 4358. The separation

(0.36 cm.^{-1}) of the rotational lines in the spectra of Hg (CD_3)₂ and Cd (CD_3)₂ is the smallest so far measured in a Raman spectrum. Results show that the experimental techniques employed are satisfactory for the study of molecules having moments of inertia up to $300 \times 10^{40} \text{ g. cm.}^2$.

Hydrogen Maser

Scientists at Harvard University have used a hydrogen maser to make a clock which promises to be 100,000 times as accurate as even the atomic clocks. The device uses a paraffin-lined quartz bulb to keep high-energy hydrogen atoms from dropping to lower energy levels. Experiments have shown that one high-energy atom can endure some 10,000 bumps, giving it a high-energy lifetime of about a second. The bulb is used as the source of 21 cm. radiation of great stability and purity of tone. Its nearly perfect monotone promises to make the maser clock a new standard for time frequency. The device is expected to be accurate to one part in 10^{15} .—(Electronics, October 28, 1960).

Radio Waves from Saturn

Professor Fred T. Haddock, Head of Radio Astronomy, University of Michigan, reported to the 13th General Assembly of the International Scientific Radio Union, the results of the findings on the detection and measurements of radio waves from Saturn. The measurements were made with the 85 ft. radio telescope through the use of a new and highly sensitive ruby maser amplifier developed by one of the laboratories of the Michigan University.

The naturally generated radio waves are emitted from various depths in the planet's atmosphere whose temperature was found to be about 100° K . Precise measurements at a number of frequencies will make it possible to obtain knowledge about the temperature and density of the rings of Saturn and about the distribution of gases in the planet's atmosphere.—(J. Frank. Inst., 1960, 270, 426).

Fish from a Depth of 7,580 Metres

Research recently conducted at the Kurile-Kamchatka depression in the Pacific by a scientific expedition of the USSR Academy of Sciences on Board the Vityaz succeeded in obtaining a hitherto unknown fish from a depth of 7,580 metres. There were no scales on its colourless body. The absence of light in the ocean depths affected the structure of its eyes: they were jelly-like and the size of a pin head. At present this antique is in the collection of

the Zoological Institute in Leningrad.—(USSR News).

Micro-Elements in Human Body

About ten elements, such as carbon, hydrogen, oxygen, nitrogen, potassium, magnesium, sulphur and iron, constitute 99% of the weight of plants and animals. A thorough chemical analysis of the cell has shown that about 50 other elements are contained in the remaining 1%. These micro-elements present in such small quantities exert a great influence on the vital activities of various organisms.

The results of the experiments on plants were amazing. Tests conducted with various micro-elements showed that micro-fertilizers cannot be replaced by the usual fertilizers (nitrogen, phosphorus and potassium). The manganese sludge or waste left over during the process of manganese-ore enrichment, deposits of which amount to many millions of tons, is found to be one of the most valuable and very interesting micro-fertilizers. In the Kharkov region (Ukrainian SSR), for instance, the addition of 150 kilograms of the sludge per hectare increased the crop yield of sugar-beet by 30%.

The role played by the micro-elements in human cells is no less interesting. Entering the organism together with food, they go to form the ferments, hormones and other substances controlling vital processes in human body. They are also constituents of many vitamins important for the organism.

About 40 to 45 various micro-elements were revealed in the human body. Even the rarest radium is present in it, deposited in the brain substance. Till recently investigations were limited to copper, cobalt, manganese, zinc, molybdenum, iodine, strontium, vanadium and iron. It appears that copper not only participates in the make-up of proteins, but may even form the copper-protein compounds. Organic substances rich in copper have already been discovered in the blood erythrocytes, liver and milk. Experiments have demonstrated that fibrin, an important part of the blood, is a chemical "cobalt protein".

Indications are that micro-elements may play an important role in the treatment of cancer. It is considered that cancer may be successfully treated by hormones inhibiting the growth of

cancer tumours. It is also known that the micro-elements have a very strong effect on the formation of such hormones. If the organism of a cancer patient lacks the micro-elements which promote the development of such hormones it may lose the power of self-protection. However, it may evidently be helped by administering the deficient hormones.—(USSR Information).

The Locust

The locust is probably the longest migrating insect on earth. It can travel up to 100 miles a day and can go on for six or seven days—that is six or seven hundred miles practically without eating. It has a wide range of tolerance to temperatures and at 115° F., feels quite happy and at home when other insects are beginning to expire from the heat. It can also withstand the low night temperatures that come in the desert. In fact, the desert locust enjoys the heat and dryness of the atmosphere of the desert, and needs the moisture to be found in the soil to hatch its eggs. It has fewer enemies than any other creature. It has an extremely interesting life-cycle consisting of two phases. In the first, it lives a solitary existence. Its hoppers are yellow or greenish-yellow in colour which gives them excellent camouflage but on multiplication they change, becoming gregarious and taking on a bold yellow and black colour. As a young insect it is sedentary by nature, lazy and wants to hide. As soon as it gets together with other locusts, it becomes gregarious, bold and very active.

We were interested to find out what made the solitary green hoppers of locusts turn black when they met other hoppers. In one experiment we put two green hoppers in a glass and the effect socially was that they both became black. When we separated them they reverted to their original green. As a further test we put a hopper in a space surrounded by mirrors and the sight of himself caused him to jump excitedly and eventually change colour. It became obvious that the black pigment was due to muscular activity, a conclusion which was further supported by an experiment in keeping the hopper on the move by artificial means, as a result of which the creature turned black—(Dr. Taskir Ahmed at the Rome Meeting of FAO on "Desert Locust").

2-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, Current Science, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates: India: Rs. 12-00. Foreign: Rs. 16-00; £ 1-4-0; \$ 4.00.

INFRA-RED SPECTRA OF WATER

PROF. DR. REINHARD MECKE

Director, Institut fur Physikalische Chemie, Universitat Freiburg I. Br., Germany

IT is well known that liquid water is practically non-transparent for infra-red radiation. This opacity is due to a strong continuous absorption of liquid water beginning at about 2.5μ and extending into the far infra-red. The origin and explanation of this continuous absorption have not yet been found. But it has certainly something to do with hydrogen bonding. If, therefore, we can find a solvent for water avoiding hydrogen bonding, it should be possible to get rid of this continuous absorption so that we would observe only the two absorption regions of the normal modes at 3500 cm^{-1} and at 1610 cm^{-1} . In seeking for such solvents which must have high polarity and ought to be quite

indeed surprising that the absorption spectrum of water in this solvent shows extremely sharp bands at 3500 cm^{-1} and 1610 cm^{-1} . There is still a continuous absorption left at 700 cm^{-1} . A very similar spectrum with sharp bands and a broad absorption at 700 cm^{-1} was observed by us recently in a new type of ice crystals which we have called type b, besides the ordinary ice crystals of type a. We observed this spectrum when water is crystallised at medium low temperature (dry ice) on rock-salt plates. The only difference is that it then splits into three components in the 3μ -region and also shows the overtone of the bending vibration at $3265/54\text{ cm}^{-1}$.¹ Figure 1² exhibits the

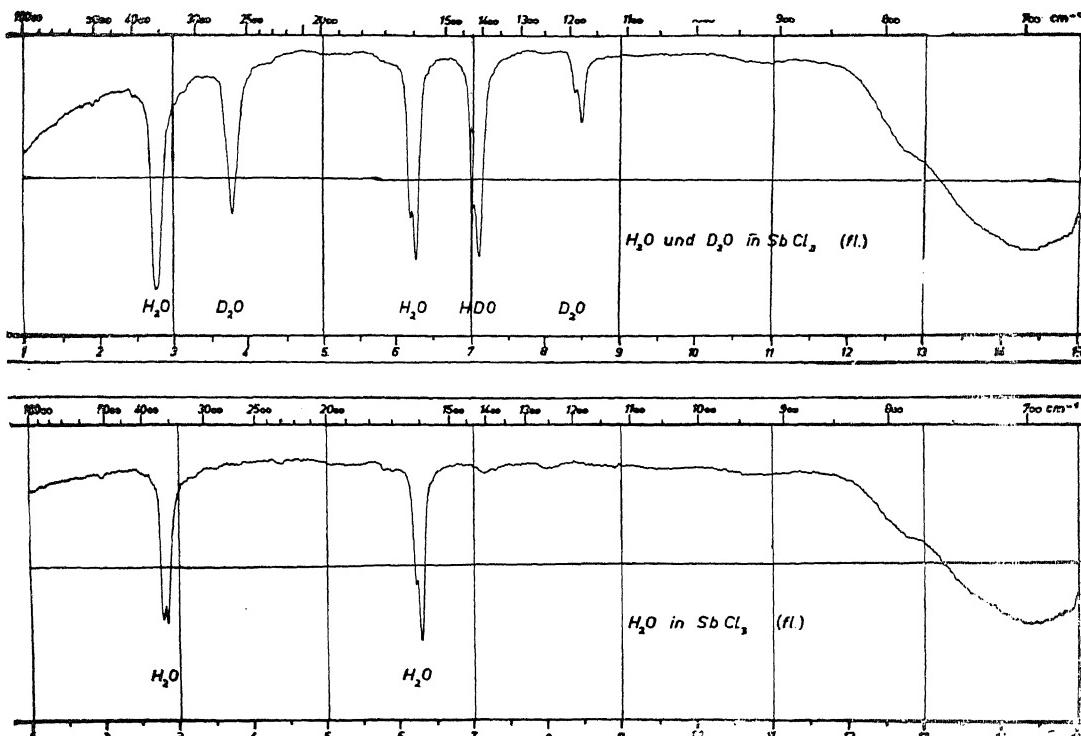


FIG. 1. Absorption spectra of light and heavy water in antimony trichloride.

transparent in the investigated infra-red region, we have tried, besides others, antimony trichloride which has a melting point at 73.4°C . Although it is not a very convenient solvent to handle it can be used for many purposes in infra-red spectroscopy. It is strongly hygroscopic, so it is not easy to get rid of the water. It is

spectrum of a mixture of heavy and light water with the three isotopic molecules H_2O , HDO and D_2O . All the bands are extremely sharp. There are some striking peculiarities in this spectrum: The two modes of stretching vibration of the HDO molecule coincide with each of the vibration of H_2O and D_2O , thus making

it evident that there is no great interaction between the vibrations of the HO and DO valence bonds. One fact which cannot be explained is the splitting of the bending vibration. Each of the three molecules shows, as with the ice crystals of type b, satellites on the short wavelength of about the same intensity ratio. As the bands are sharp and coincide with the frequencies of the vapour state, there can be no hydrogen bonding. But the highly polar antimony trichloride molecule certainly would associate with the water molecule. This association must therefore take place by some sort of oxygen bonding to the antimony atom. The splitting may be originated by a coupling effect of the antimony atom. A further point of interest is the same intensity ratio of the satellite to the main absorption band in each isotopic molecule. Without going into further details, I would call attention to the following fact which has not yet been fully realised :

From an infra-red spectrum we get two main kinds of information : (a) normal frequency and (b) total intensity of a band.

The square of the frequency of a normal vibration is, as is well known, proportional to the force-constant (*f*) and to the reciprocal mass ($1/m$) :

$$(a) (2\pi\nu)^2 = f \cdot \left(\frac{1}{m}\right).$$

On the other side, the square of the vibrating charge (*e*) is also proportional to the same force-constant and to the polarisability α of the normal mode :

$$(b) (e)^2 = f \cdot \alpha.$$

The polarisability of a vibration can now be quite easily measured by the total integrated intensity over $d\lambda$ of the band :

$$(c) \alpha = \frac{3}{8\pi^2 N} \int \epsilon_\lambda d\lambda$$

$$(d) (2\pi e)^2 = f \left(\frac{3}{2\pi N}\right) \int \epsilon_\lambda d\lambda.$$

(*e*—molar extinction coefficient ; *N*—mole-number).

If, therefore, the effective electrical charge of the vibration is *not* dependent on the amplitude of the vibrating mass, the isotopic compounds must have the same intensity in the corresponding bands. As we now have found a solvent which will dissolve water and other simple compounds quite readily in different concentration, we are now able to go into studying this intensity phenomenon of the infra-red spectra of deuterated simple compounds and we shall do so.

-
1. Mutter, R., Mecke, R. and Luttko, W., *Z. f. phys. Chem.*, Neue Folge, 1959, **19**, 83.
 2. The spectra were taken by Dr. E. Klee at my Institute.
-

ROCKET TO VENUS

WHAT indeed was a significant step forward in space research was the launching of a rocket to the planet Venus by Russia on February 12, 1961. The method of launching itself was unusual and showed the greatest scientific precision involved. The "interplanetary station", as the rocket is called, was launched from a heavy artificial satellite which was put in orbit round the earth earlier in the day, by an improved multistage rocket.

The weight of the automatic interplanetary station is 643.5 kilograms (1420 pounds). Radio transmissions from the Venus rocket are made on the frequency of 922.8 kilocycles on command from the earth. According to the Russian announcement the purpose of the rocket was to carry out a programme of physical observations in outer space. On February 17th the announcement said that the interplanetary station had travelled a distance of about 1,173,000 miles and was going at a speed of $2\frac{1}{2}$ miles per second, and that the equipments, actuated by solar batteries, were functioning normally. The rocket is expected to reach the area of the

planet Venus in the second half of May, 1961.

One result of the revolutionary "double system" used in launching the Venus probe is a one-third reduction in the time previously considered necessary for the trip from Earth to Venus. It was calculated by Soviet scientists that with an estimated initial speed of 12 km. per second, the trip to Venus would take 146 days on the most economical orbit. Thus the utilisation of a space platform to launch the actual Venus rocket has permitted an increase of the "breakaway" speed and correspondingly reduced the flight time to Venus.

Venus is nearly of the same size as earth, its diameter being 7,600 miles. Its mean distance from the sun is 67 million miles and its orbit is almost circular ; its period of revolution round the sun is 225 days. Its distance from the earth varies from a maximum of 160 million miles to a minimum of 26 million miles. It comes closer to the earth than any other planet. Venus is currently on one of its closest approaches to the earth, about 35 million miles away.

PHOTOSYNTHESIS*

T. S. SADASIVAN

University Botany Laboratory, Madras-5

THAT isolated chloroplasts are capable of forming carbohydrates from CO_2 and H_2O simultaneously evolving O_2 without any energy other than visible light has given a spectacular lead and paved the way for investigating the fundamental problem of photosynthesis, i.e., the ability to convert light into chemical energy. The theory that photolysis of water is the basic reaction has now been re-examined using isolated chloroplasts and cell-free particles of the photosynthetic bacterium, *Chromatium*, and the results of these experiments are indicative of photosynthetic phosphorylation as a more likely factor in the two systems than photolysis of water as hitherto supposed (photolysis in the botanical sense means "the grouping of chloroplasts in relation to the amount of light falling on plant"; in the chemical sense it means "the decomposition or dissociation of a molecule as a result of the absorption of light"). Isolated chloroplasts have, therefore, provided an effective experimental approach to the separation of the light-dependent phase of photosynthesis in which O_2 , TPNH and ATP are formed and the dark phase during which CO_2 is assimilated. The conversion of absorbed light energy into chemical energy, used for CO_2 assimilation in the dark, occurs during the photochemical reactions in which chloroplasts evolve O_2 and form assimilatory power, i.e., ATP and TPNH.

With this background let us now examine the various views put forward in understanding many aspects of this phenomenon of photosynthesis. It is generally recognized that in photosynthesis oxido-reduction takes place by the utilization of hydrogen from water for reduction of CO_2 . Therefore, if chlorophyll were involved, as it seems to, in the chain of reactions culminating in the transfer of hydrogen from water to CO_2 , the obvious thing to expect is a reversible photochemical oxidation or reduction of chlorophyll resulting in the storage of light energy in its photoproducts presumably

as reversibly acting unstable quanta. Indeed, this has been shown early as feasible (reversible photochemical oxidation of the pigment in the presence of ferric ions) but whether this is what happens *in vivo* is a moot point. Chloroplast reaction in relation to hydrogen transport is well summarized in Fig. 1. It shows reducing

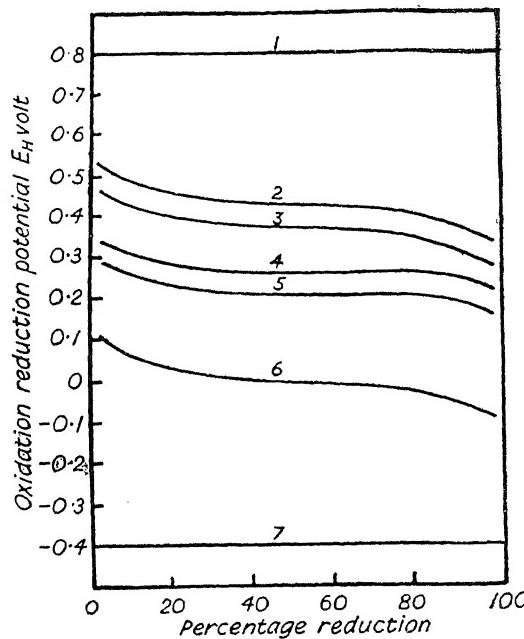


FIG. 1. Potentials and percentage reduction for substances taking part in chloroplast reaction as shown by R. Hill: 1. oxygen; 2. ferricyanide; 3. cytochrome *f*; 4. quinone; 5. 2,6 dichlorindophenol; 6. ferric oxalate; 7. hydrogen (from Hill and Whittingham, 1958).

properties of the chloroplast system, i.e., relationship between the electrode potentials and the percentage reduction of the effective reagents. The reduction of ferric oxalate represents the greatest reducing potential that has yet been obtained in chloroplast reaction. Therefore, chloroplast preparations do not 'split water' to the extent required by the simple formulation of photosynthesis. Two interpretations are possible: (a) either the chloroplast reaction *in vitro* is an artefact and has no direct correlation with processes of reduction occurring in the living cell, or (b) the reduction of CO_2 requires more than the four equivalents of hydrogen chemically necessary. Illuminated

* Summary of address delivered to the Indian Academy of Sciences at the 26th Annual Session at the University of Madras, December, 1960.

The following abbreviations will be used in the text: ADP, ATP, adenosine di- and tri-phosphates; FMN, flavin mono-nucleotide; PGA, phosphoglyceric acid; Ru-D-P, ribulose diphosphate; R-5-P, ribose-5-phosphate; RDP, ribose diphosphate; TPN, triphosphopyridine nucleotide; TPNH, triphosphopyridine nucleotide, reduced form.

chloroplasts catalyse the production of O_2 from H_2O in the presence of certain hydrogen acceptors in a reaction which shows many of the characteristics of the O_2 -producing reaction in photosynthesis. However, the reducing properties of illuminated chloroplasts are not of sufficient potential to account for a reduction of CO_2 by reaction with the minimum number of equivalents of H_2 . In the present state of our knowledge this conclusion would appear fairly satisfactory although one must admit that positive proof for such oxido-reduction is yet to be found. The intermediates that store light energy subsequent to the photochemical stage are now known to be reduced forms of pyridine nucleotides and high energy phosphates. However, that does not represent the entire list as newer intermediate compounds taking part in this remarkable phenomenon of storage of light energy await discovery and characterization.

Simultaneous action of light of different wavelengths could favour the course of photosynthesis as for example blue-green light of very low intensity was shown to greatly increase the quantum yield of photosynthesis by *Chlorella* in the presence of red light and also due to the action of blue light the long wave limit of *Chlorella* photosynthesis was noted to shift to extreme red region. Nevertheless, joint action of quanta of red and blue light is not indispensable for photosynthesis as, indeed, plant growth in red light alone is known. A further point of interest is that in the region of 450 to 580 $m\mu$ O_2 uptake has been noted to increase in plant organs containing no chlorophyll. Light could also affect activity of photoreduced forms of chlorophyll.

Quite recently, Arnon and his collaborators discovered that isolated chloroplasts could synthesize ATP in light. They succeeded in separating the light and dark phases of reaction resulting in the formation of the reduced form of TPN and ATP on illuminating "grana" in the absence of oxygen. The interesting point is that, on illuminating isolated chloroplast, inorganic phosphate gets incorporated into ATP without liberation or uptake of O_2 and this Arnon designated as "cyclic phosphorylation". The rate at which this process proceeded was accelerated if co-factors like FMN, ascorbic acid, vitamin K or similar oxido-reductive systems that could initiate electron transfer were added. Three products of the light reactions in chloroplasts, O_2 , ATP and TPNH, are now known to be formed (Fig. 2). Reactions 1 and 2 reveal an unknown capacity of chloroplasts to use light energy for the formation of

energy rich pyrophosphate bonds of ATP and is now designated as photosynthetic phosphorylation as distinguished from oxidative phosphorylation by mitochondria. Reaction 1 is now known as "cyclic" and reaction 2 as "non-cyclic" photo-phosphorylation where only part of the light energy absorbed by chlorophyll is used for the formation of ATP; the remainder is used for formation of a reductant, TPNH, which provides the 'hydrogens' needed for the conversion of CO_2 to sugars. Reaction 3 is a non-physiologic variant of reaction 2 in which TPNH is replaced by ferricyanide.

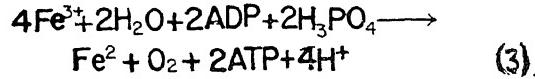
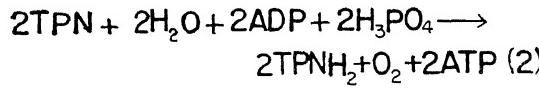
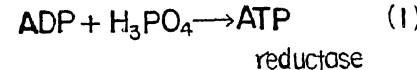


FIG. 2. Photochemical reactions as postulated by Arnon (1959).

Arnon went further and gave a new orientation to the non-cyclic electron transport process which in photosynthesis of green plants results in a light dependent reduction of TPN, evolution of O_2 and the formation of ATP (Fig. 3). It

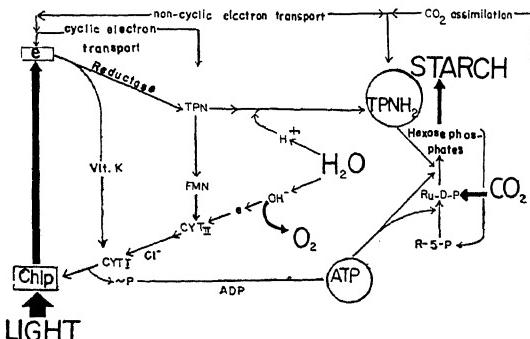


FIG. 3. Scheme for photosynthesis proposed by Arnon (1959).

differs from the cyclic pathway in that an electron expelled does not return to the chlorophyll molecule but is removed from the cyclic pathway by TPN and used either for the reduction of CO_2 and the formation of carbohydrates or under special conditions for the production and accumulation of TPNH. This scheme of Arnon brings out that, chlorophyll, on absorbing a light quantum, becomes 'excited' and expels high-energy level electrons. In both

No. 2]
Feb. 1961]

Photosynthesis

green plants and photosynthetic bacteria this energy is converted into the pyrophosphate bond-energy of ATP during a 'downhill' return of electrons to chlorophyll through a cyclic electron transport system of the vitamin K type. In the green plants, there is a second cyclic electron transport system of the FMN type for forming ATP and also an open non-cyclic mechanism of electron transport to TPN and this results in evolution of O_2 . Cytochrome components are also visualized in electron transport of both cyclic and non-cyclic mechanisms. Photosynthetic bacteria seem to use light energy only for formation of ATP by the vitamin K type of cyclic photophosphorylation. Green plants, however, require both cyclic and non-cyclic electron transport systems for formation of assimilatory power, ATP and TPNH (photosynthetic triphosphopyridine nucleotide reductase, the reducing factor for chloroplasts has now been crystallized; this protein is considered to occupy a prominent place in the reducing properties of light-activated chloroplasts). ATP and TPNH are then used for assimilation of CO_2 to form sugar and starch as dark reactions with regeneration of R-5-P and Ru-D-P. Thus, the formation in light, of reduced phridine nucleotides and high-energy phosphates and the subsequent dark reactions of CO_2 assimilation using these compounds is the new concept but how these reaction-conjugation mechanisms link up with the primary photochemical process occurring in chlorophyll remain largely speculative.

During the last decade Calvin and his collaborators using $C^{14}O_2$ showed that CO_2 reduction by plants resulted essentially in the formation of Ru-D-P subsequently converted into PGA (Figs. 4, 5). For one turn of the

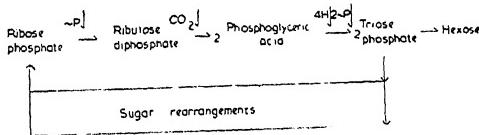


FIG. 4. Photosynthetic carbon cycle of Calvin (from Hill and Whittingham, 1958).

cycle one molecule of CO_2 is fixed and this requires the transfer of four hydrogen atoms and formation of three active phosphate groups. This double requirement has been shown with particulate preparations of spinach leaves. All the energy requirements for the operation of the cycle were present together with added ATP. No reaction occurred until the addition of one of the sugar phosphates as primer after which

there was continued fixation of CO_2 and formation of hexose phosphate. A rapid decrease in CO_2 concentration was accompanied by a rapid fall in PGA and rise in RDP. This is a notable contribution as it is the first analytical study of changes in intermediates *in vivo* within times approaching those of individual reaction velocity constants.

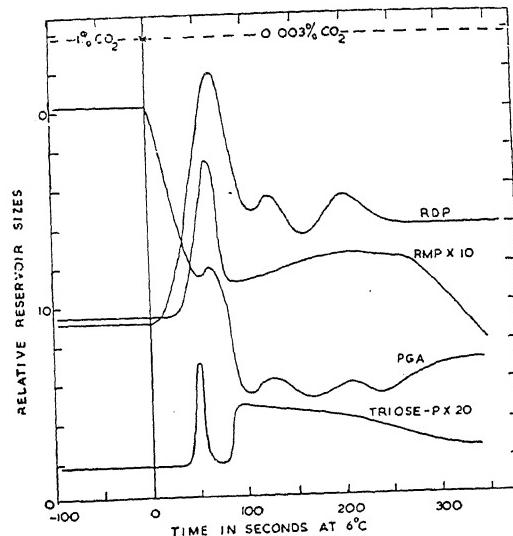


FIG. 5. Changes in the concentrations of phosphoglyceric acid, ribose, di- and mono-phosphate and triose phosphate consequent to a reduction in CO_2 concentration as shown by A. T. Wilson and M. Calvin (from Hill and Whittingham, 1958).

The nature of the enzyme systems taking part in the formation of the intermediates of the cycle of photosynthesis are being better understood now. In the green plant, Coenzyme II is postulated as the hydrogen acceptor for chloroplast functioning as a photochemical system. Coenzyme II reduction involves an intermediary which has been shown to be a soluble protein separable from the green insoluble system containing chlorophyll and cytochrome. The insoluble portion seems to possess the ability to initiate phosphorylation since H_2 -acceptors could replace Coenzyme II and soluble protein (see Hill and Bendall). The chloroplast system seems to act by reversing a stepwise H_2 transfer and phosphorylation is a light reaction of a reductive nature against a thermochemical gradient. The emphasis laid by Hill and his collaborators is on a two step light-driven reaction involving cytochrome b_6 and f, somewhat analogous to hydrogen transfer characteristic of mitochondria. Admittedly, such a phosphorylation step between cytochrome b_6 and f has not found experimental evidence

in green plants. Indeed, one of the drawbacks of the Arnon scheme is that the properties ascribed to cytochromes do not seem to agree with their *in vitro* known properties but that is no argument to underestimate the major discovery that the rate of production of O_2 doubled in the presence of ADP, magnesium and inorganic phosphate. Therefore, it becomes obvious that, if it is assumed that hydrogen (or electron) transfer is the basic mechanism by which cytochrome functions in chloroplasts, there ought to be more than one light-driven reaction acting against the thermochemical gradient.

The recent writings of Nichiporovich *et al.* (see Krasnovsky) indicate that relative rapidity of entry and subsequent distribution of labelled carbon in carbohydrates, amino-acids, organic acids and proteins vary with plant species, age, nutrition and intensity and spectral composition of the incident light. They claim that red light promoted increased carbohydrate formation while blue light promoted amino-acid and protein formation. These workers presume that this is attributable to the activation of cytochrome, flavin systems and respiration in blue light and its consequent effect on alteration of the ratio of oxidative to reductive reactions of photosynthesis. Be that as it may, it is quite obvious that, functioning carbon cycles must have an uninterrupted supply of products such as reduced pyridine-nucleotides and ATP, which, indeed, are resultant products of photochemical reactions. The active H_2 is lost by the reduced pyridine nucleotide in the carbon cycle and DPN (diphosphopyridine nucleotide) and TPN return to the system of photochemical reactions. Similarly, ADP returns to the photosynthetic phosphorylation cycle.

Deuterium (D_2O) and tritium (T_2O), the heavy hydrogen isotope and radioactive hydrogen, respectively, have been used alongside $C^{14}O_2$ in experiments on photosynthesis to understand the role of H_2 in the process. Accumulation of tritium was shown in glycolic, phosphoglyceric and glutamic acid in light experiments and in the dark, accumulation was greater in amino-acids. Much of the experimental work in this field remains inconclusive and generally point to the remote possibility of primary reversible dehydrogenation being the venue of participation of chlorophyll in photosynthesis. The use of heavy oxygen (O^{18}) in photosynthesis showed its accumulation in sugar phosphates and even here much work seems imminent if we were to understand the many mechanisms involved. However, the use

of isotopes of H_2 or O_2 have so far yielded no tangible results and the mechanism of liberation of molecular oxygen which is the bed-rock of the phenomenon is still hypothetical. It has been suggested that intermediates of the oxidation of water resulting in the formation of molecular oxygen are evanescent and, since the process is a high velocity reaction, have defied detection. Despite all these results that have accrued by using isotope techniques, no decisive stand could be taken other than the path of carbon in photosynthesis being a multi-step cyclic process where CO_2 is bound by a compound (this according to Calvin is Ru-D-P subsequently converted into PGA) which is continually regenerated.

Summing up it could be stated that TPN-coupled phosphorylation, i.e., synthesis of ATP, without evolution of O_2 , is the new concept of Arnon that warrants attention and it has much experimental proof. Therefore, the conversion of light into chemical energy is fundamentally linked with phosphorus than with carbon. The view that efficient transfer of light energy into high-energy phosphate by a process recombination of products of photolysis cannot yet be thrown overboard. But in what way and how much of this high-energy phosphate is utilized in reduction of CO_2 may well have to be explained. Comparing chloroplast and chromatophore reactions there is undoubtedly similarity in the photophosphorylation process of both systems; in essence, it is an anaerobic process depending on electron transport between photochemical reductant and oxidant (Fig. 6).

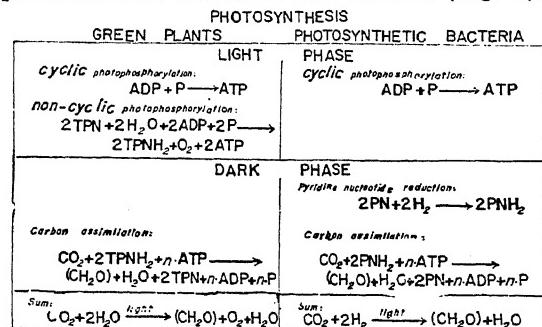


FIG. 6. Comparison of photosynthetic systems in green plants and photosynthetic bacteria (after Arnon, 1959).

However, the similarity exists only for the vitamin K pathway of cyclic photophosphorylation, the FMN pathway as well as the non-cyclic pathway being peculiar to chloroplasts. Therefore, with the recognition of cyclic photophosphorylation (vitamin K pathway) as

a common process to photosynthesis in green plants and photosynthetic bacteria, it is possible to omit photolysis of water as a common photochemical reaction. Thus, the evolution of O₂ by green plants is a consequence of some special way in which they form TPNH in light for which water is the hydrogen donor. To keep chlorophyll functioning, electrons removed by non-cyclic transport have to be continuously replenished possibly by electrons donated by the hydroxyl ions via a cytochrome chain and yielding molecular oxygen in the process (Fig. 3).

I have endeavoured to present much of what is known about photosynthesis in the hope that it would enthuse workers to study this fascinating subject from the biochemical, biophysical and physiological angles. It is a pleasure to acknowledge with thanks help of my colleagues : Drs. L. Saraswathi-Devi, D. Subramanian and S. Suryanarayanan for critical review of this manuscript.

1. Arnon, D. I., *Nature, Lond.*, 1959, **184**, 10.
2. Hill, R. and Whittingham, C. P., *Photosynthesis*, Methuen & Co., London, 1958.
3. — and Bendall, F., *Nature, Lond.*, 1960, **186**, 136.
4. — and —, *Ibid.*, 1960, **187**, 417.
5. Kandler, O., *Annu. Rev. Pl. Physiol.*, 1960, **11**, 37.
6. Krasnovsky, A. A., *Ibid.*, 1960, **11**, 363.

ADDENDUM

Since writing this up for the press an excellently written and fully illustrated article

on the subject by D. I. Arnon has come to my notice (*Scientific American*, 1960, 203, 104). The reader would do well to peruse this. Much of the ground I have covered is what Arnon's latest article contains except that the non-cyclic photophosphorylation referred to earlier as peculiar to green plants (see Fig. 6) has now turned out to be common for the photosynthetic bacteria also. However, the hydrogen donor in the latter case is not water but reducing substances like succinate.

Arnon has also added a philosophic note towards the end on "Photosynthesis and Evolution" which may be summarized as : When life appeared there was little oxygen in the atmosphere but had hydrogen as a free gas. In the same way as the bacterium *Chromatium* has been shown to be capable of making ATP in visible sunlight, the chlorophyll molecule, just evolved, is presumed to do in cells under anaerobic conditions. Thus, this vestige of a functional mechanism of cyclic photophosphorylation seems still to be retained by the aerobic plants we now see despite their ability in addition to make ATP through respiration. Then perhaps came a further evolutionary step, the non-cyclic process simulating the bacterial function of reducing pyridine nucleotide without using molecular hydrogen. The acme of perfection in photosynthesis eventually came from the ability of having water to donate the needed hydrogen and liberating oxygen into the atmosphere.

SYMPOSIUM ON COLLAGEN

A SYMPOSIUM on Collagen, sponsored by the Central Leather Research Institute, Madras, was held on the 29th and 30th November, 1960. Prof. M. S. Thacker, Director-General, Scientific and Industrial Research, India, inaugurated the symposium at a function presided over by Dr. A. Lakshmanaswamy Mudaliar, Vice-Chancellor of the Madras University. The inauguration was followed by the Conference lecture on "Structure of Fibrous Proteins and Polypeptides" by Prof. G. N. Ramachandran of the University of Madras. In this lecture, Prof. Ramachandran summarized the present state of knowledge on proteins and polypeptides, and dealt in detail with the structural problems associated with collagen and feather keratin.

Thirty-five papers were contributed to the symposium, and it may be noted that more than half the number came from scientists and technologists representing nine different countries of the world outside India.

In the first session on "Structural Studies" presided over by Dr. S. Ramaseshan of the Indian Institute of Science, Bangalore, ten papers were presented and discussed. Many proteins such as insulin, tobacco mosaic virus, myoglobin, etc., form single crystals ; they have a specific sequence of amino-acid residues and are arranged in a perfect crystalline lattice array ; their X-ray patterns show hundreds of sharp spots known in conventional X-ray crystallography. On the other hand, proteins like collagen, keratin, etc., form fibres and they differ from crystalline proteins not so much in their intrinsic chemical nature as in their physical state of aggregation. In fact it is this aggregation which endows collagen, for example, with those characteristic properties which make it an important biological building block. X-ray patterns of fibrous proteins show only a few diffraction streaks, and the elucidation of the structure is beset with difficulties. The

laws of geometrical crystallography have been worked out and well understood, but the laws of "fibre crystallography" are still in the process of being formulated.

The first breakthrough in our knowledge of the structure of collagen was made in 1954 when Ramachandran and Kartha gave their model of the triple helical structure. For stereochemical reasons Rich and Crick (1955) modified this structure by postulating the existence of only one cross-linking hydrogen-bond per three residues. In this symposium Ramachandran and his collaborators have again revived the original two-hydrogen-bond-per-three-residues structure with slight alterations. They have justified this structure from stereochemical criteria and claim that it satisfies all the X-ray and infra-red data. The structure of feather keratin is also shown to be of the collagen triple helix type.

The nine-residue-per-turn model was presented by Huggins (U.S.A.). An extremely interesting paper by A. R. Downie and A. A. Randall (England) showed from extensive data on mutarotation that there was a *cis-trans* isomerism of the peptide group—a fact which does not appear to corroborate Ramachandran's structure. The template theory and the role of collagen in the formation of bones and teeth, and the problem of collagen in silicosis were discussed by Seifert (Germany). Studies of the changes in X-ray diagrams of collagen derived from human tendon of different age groups, presented by Kratky (Austria), proved of interest as it dealt with the problem of old age.

In the second session on "Medical and Biochemical Studies" presided over by Dr. B. S. Gould of M.I.T. (U.S.A.), a variety of topics were dealt with in thirteen papers. Several papers were concerned with the structure of collagen, as deduced from analysis of the products obtained from it by enzymatic cleavage. Unusual linkages in collagen were described by Gallop (U.S.A.). Grassmann (Germany) postulated that the sequence P-R-Gly-P (where P stands for proline or hydroxyproline and R for an amino-acid) was attacked by collagenase. The stability of collagen was attributed by Banga (Hungary), to the existence of 'paracollagen' as, by removing this component, collagen fibres lost their strength.

Orekovich (USSR) showed that the macromolecules of citrate-soluble procollagen consisted of two particles of the α -component and one of the β -component whereas in neutral

salt-soluble procollagen, the β -component was present in small amounts.

Regarding biosynthesis of collagen, the occurrence of a proline-rich precursor, which was then converted by hydroxylation of the proline to collagen, was mentioned by Gould (U.S.A.). An adequate supply of ascorbic acid was necessary for collagen maintenance in so far as newly formed collagen was concerned. Collagen resorption occurred by some yet unclarified mechanism of collagenolysis. On the medical aspect of collagen research, it was reported that protein deficiency either inhibited the formation of fibrous tissue or promoted the disappearance of formed fibrous tissue in the liver.

Gustavson (Sweden) described the reaction of teleost and bovine skin collagen to specific agents and postulated the presence of covalent cross-linkages in bovine skin collagen. An analysis of gelatins (obtained from hides and bones) by Pouradier and Accary (France) showed that nucleic acids were bound to collagen.

In the third session on the "Physical, Chemical and Technological Studies" presided over by Dr. P. M. Gallop of Yeshiva University, New York, twelve papers were presented. Witnauer (U.S.A.) described the shrinkage of collagen and leather as a melting phenomenon. Basu discussed the effect of non-tans and lyotropic agents on the optical birefringence of tanned and modified collagen. A study on the relation between shrinkage and birefringence in the case of elastoidin was reported by Nayudamma and Ramanathan.

On the morphological aspects, a detailed analysis, by Nemetschek (Germany), of the cross-striations observed on collagen fibrils, treated in various ways, confirmed the accepted ideas on the evolution of collagen from tropocollagen particles.

Eucollagen reconstituted from bone was shown not to have the cross-striations exhibited by collagen fibrils reconstituted from other sources. A twisted appearance of the fibrils was recorded by Reed (U.K.) in some cases. The important point arose that the twisted appearance might be a reflection of the helical nature of the protofibrils.

The factors governing elastolysis were discussed. It was demonstrated by Hall (U.K.) that the reaction between elastase and elastin obeyed an unusual empirical relationship.

To summarize, the seminar had brought out, more than ever, the potentialities of research on collagen and emphasised that the number of sciences useful for investigations in this field was large.

LETTERS TO THE EDITOR

THE ELASTIC SCATTERING OF 426 Mev ELECTRONS BY LITHIUM-6

The differential scattering cross-sections for the elastic scattering of 426 Mev electrons by Lithium has been experimentally obtained by Burleson and Hofstadter.¹ The experimental values are given in column II of Table I. They have also tried to explain the same on some standard nuclear models, but no single unique charge distribution for the nucleus of Lithium-6 could be formed.

It has been shown by Mathur and Gatha² that for a nonsingular electrostatic potential the scattering amplitude in the first Born approximation is given by

$$f(\theta) = - \frac{8\pi EZe^2}{(\hbar c)^2 As^3} \int_0^\infty \rho(r) \sin(sr) r dr \quad (1)$$

where,

$$s = 2k \sin \frac{\theta}{2},$$

while the other symbols have their usual meanings.

The above expression can be stated as

$$f(\theta) = - \frac{8\pi EZe^2 A^{2/3}}{(\hbar c)^2 s^3} \int_0^\infty \rho(r') \sin(s'r') r' dr' \quad (2)$$

where,

$$s' = sA^{1/3} \quad \text{and}$$

$$r' = rA^{-1/3}$$

In the first Born approximation, the scattering cross-section for elastic scattering is given by

$$\sigma(\theta) = \left[1 - \beta^2 \sin^2 \frac{\theta}{2} \right] |f(\theta)|^2 \quad (3)$$

where,

$$\beta = \frac{v}{c}.$$

Now, from the study of high energy nucleon scattering by nuclei Gatha, Shah and Patel³ have proposed the following characteristic nuclear density distribution for the light elements :

$$\rho(r') = \sum_{a=1}^3 a_a \exp.(-\beta_a r'^2) \quad (4)$$

where, $a_1 = 0.25 \times 10^{39} \text{ cm.}^{-3}$
 $a_2 = 0.19 \times 10^{39} \text{ cm.}^{-3}$
 $a_3 = 0.1 \times 10^{39} \text{ cm.}^{-3}$
 $\beta_1 = 28.94 \times 10^{26} \text{ cm.}^{-2}$
 $\beta_2 = 3.83 \times 10^{26} \text{ cm.}^{-2}$
 $\beta_3 = 0.75 \times 10^{26} \text{ cm.}^{-2}$

This density distribution explains successfully the scattering of 340 Mev protons by Ca, Al, etc. It also explains the scattering of 125 Mev electrons by Be as shown by Gatha, Patel and Patel.⁴

Later on, Gatha and Shah⁵ have proposed an improved characteristic nuclear density distribution for light elements as given below :

$$\rho(r') = a_1 \exp.(-\beta_1 r'^2) + a_2 \exp.(-\beta_2 r'^2) \\ \times \{1 - \beta_3 r'^2 + f_4 r'^4\} \quad (5)$$

where, $a_1 = 0.12 \times 10^{39} \text{ cm.}^{-3}$

$$a_2 = 0.25 \times 10^{39} \text{ cm.}^{-3}$$

$$\beta_1 = 8.62 \times 10^{26} \text{ cm.}^{-2}$$

$$\beta_2 = 1.09 \times 10^{26} \text{ cm.}^{-2}$$

$$\beta_3 = 0.44 \times 10^{26} \text{ cm.}^{-2}$$

$$\beta_4 = 0.13 \times 10^{52} \text{ cm.}^{-4}$$

On the basis of this improved density distribution Gatha, Shah and Advani⁵ have successfully explained the elastic scattering of 125 Mev and 190 Mev electrons by Be.

We have calculated the differential scattering cross-sections of 426 Mev electrons by Li-6 using both the above density distributions. The results on the basis of density distribution given in equation (4) are stated in column III of Table I and those on the basis of improved density distribution given in equation (5) are stated in column IV of Table I. It can be seen that neither of the density distributions gives the values agreeing with the experimental values.

TABLE I
Differential scattering cross-sections for
426 Mev electrons by Li-6

I θ	II (Experimental values) $\sigma(\theta) \times 10^{-32}$	III (Gatha et al. ³) $\sigma(\theta) \times 10^{-32}$	IV (Gatha and Shah ⁵) $\sigma(\theta) \times 10^{-32}$	V (Authors' values) $\sigma(\theta) \times 10^{-32}$
33°	149	278.34	404.88	155.2
35°	91.4	170.22	256.72	91.77
37.5°	43.1	90.43	148.30	47.41
40°	24.1	50.84	87.04	24.41
41.25°	17.7	38.49	67.14	17.42
42.5°	11.4	19.18	52.5	12.47
45°	6.45	10.85	31.53	6.82
47.5°	2.89	10.44	19.42	2.80
50°	1.49	6.28	12.06	1.79
52.5°	0.776	4.20	7.58	0.777
55°	0.370	2.78	4.78	0.389
57.7°	0.211	2.53	2.99	0.177

Hence we propose a density distribution as shown below:

$$\rho(r') = \alpha \exp(-\beta r'^2) \quad (6)$$

where, $\alpha = 0.13 \times 10^{39} \text{ cm.}^{-3}$
 $\beta = 1.05 \times 10^{26} \text{ cm.}^{-2}$

The calculated differential scattering cross-sections on the basis of proposed nuclear density distribution is given in column V of Table I. It can be seen that the calculated values of the differential cross-sections agree to a very large extent with the experimental results.

Physics Department,
M.G. Science Institute,
Ahmedabad-9, December 21, 1960.

N. J. PATEL.

C. M. BHAVSAR.

1. Burleson, G. R. and Hofstadter, R., *Phys. Rev.*, 1958, **112**, 1282.
2. Matlur, A. L. and Gatha, K. M., *Proc. Phys. Soc.*, 1953, **66 A**, 773.
3. Gatha, K. M., Shah, G. Z. and Patel, N. J., *Ibid.*, 1954, **67**, 773.
4. —, Patel, N. J. and Patel, P. F., *Ibid.*, 1954, **67**, 1111.
5. Advani, M. K., Shah, G. Z. and Gatha, K. M., *Curr. Sci.*, 1955, **11**, 267.

CRYSTAL STRUCTURE DATA OF SOME RHODITES AND RUTHENITES

RUDORFF AND REUTER¹ investigated the crystal structures of MgRh_2O_4 and ZnRh_2O_4 and found that they were normal spinels. Recently Bertaut *et al.*² published data on crystal structure of rhodites of Mg, Zn, Cd, Mn, Co, Ni and Cu. In this article data on crystal structures of rhodites of Mg, Zn, Cd, Mn, Cu, Fe, Cr, La and Li and strontium ruthenite are presented.

The rhodites and ruthenites were prepared by firing an intimate mixture of rhodium or ruthenium metal and a metal oxide or carbonate in an atmosphere of pure dry oxygen in a Johnson Matthey platinum-rhodium wound furnace giving a maximum working temperature of 1350°C . The compositions of the products were determined on the basis of the oxygen intake of rhodium or ruthenium metal as determined by increase in weight of the product. From X-ray powder photographs obtained in a 9 cm. Bradley³ camera the unit cell dimensions were determined by standard methods.

The results are summarized in Table I. The data of other workers are given in the last column for comparison.

The crystal structure data show that rhodites of Mg, Zn, Cd, Mn and Li are cubic spinels. Lithium and Manganic rhodites appear to have a defect structure like that of $\gamma-\text{Fe}_2\text{O}_3$. Copper rhodite is a tetragonal spinel with negative deformation ($c/a < 1$). Ilmenite structure is shown by rhodites of Fe and Cr while Lanthanum rhodite and Strontium ruthenite possess the perovskite structure. Attempts to prepare other ruthenites did not meet with success. It will be seen that the results of the author are in general agreement with those of other workers.

The work described in this article was carried out by the author in 1953-54, during the tenure of a Government of India scholarship at the Imperial College of Science and Technology,

TABLE I
Table of results

Element other than Rh or Ru	Supposed valency of Rh or Ru	Product	Symmetry	Lattice constant	
				Author	Other workers
Magnesium	..	3	Spinel	$a=8.51 \text{ \AA}$	8.53^2 8.51^1
Zinc	..	3	do.	$a=8.52 \text{ \AA}$	8.54^2 8.52^1
Cadmium	..	3	do.	$a=8.76 \text{ \AA}$	8.78^2
Manganese (II)	..	3	do.	$a=8.60 \text{ \AA}$	8.61^2
do. (III)	..	3	do.	$a=8.57 \text{ \AA}$	..
Copper (II)	..	3	Tetragonal	$a=8.72 \text{ \AA}$	8.70^2
			Spinel	$a=8.23 \text{ \AA}$	7.91
Lithium	..	3	do.	$a=8.46 \text{ \AA}$	..
Iron (III)	..	3	Ilmenite	$a=5.46 \text{ \AA}$ $a=55^\circ26'$	..
Chromium (III)	..	3	do.	$a=5.42 \text{ \AA}$ $a=53^\circ12'$	..
Lanthanum	..	3	Perovskite	$a=3.94 \text{ \AA}$	..
Strontrium	..	4	do.	$a=3.93 \text{ \AA}$	..

London, under the direction of Dr. A. J. E. Welch.

D. D. KHANOLKAR.

Institute of Armament Studies,
Kirkee, Poona-3, November 25, 1960.

1. Rudorff and Reuter, *Z. anorg. Chem.*, 1947, **253**, 104.
2. Bertaut et al., *Compt. rend.*, 1959, **249**, 726.
3. Bradley et al., *J. Sci. Instruments*, 1941, **18**, 216.

A PRELIMINARY STUDY OF THE CRYSTAL STRUCTURE OF $\text{La}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24 \text{H}_2\text{O}$

IN view of the stimulating interest, in recent years, in the paramagnetic resonance studies (involving rare-earth double nitrates) in the solid state, work on the crystal structure determination of Lanthanum Magnesium Nitrate was undertaken at the suggestion of Professor B. Bleaney of Clarendon Laboratory, Oxford.

It is well known that the double nitrates of rare-earths form an isomorphous series of the formula $\text{A}_2\text{B}_3(\text{NO}_3)_{12} \cdot 24 \text{H}_2\text{O}$ where A is the trivalent rare-earth ion and B is a divalent metal such as Mg or Zn. The external morphology of the various members of the series has been described by Groth (1908) who has classified them as 'trigonal' with axial angle close to 80° .

Details of the crystal structure of these compounds are unknown. However, Powell (unpublished), at Oxford, has determined the structure of the lattice formed by the cerium ions in cerium magnesium nitrate: the cerium atoms lie on a rhombohedral lattice with a unit cell of side 8.51 \AA and interaxial angle of 79.5° (see Cooke et al., 1953).

Crystals of $\text{La}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24 \text{H}_2\text{O}$, suitable for X-ray analysis, were obtained by mixing $\text{La}(\text{NO}_3)_3 \cdot 6 \text{H}_2\text{O}$ and $\text{Mg}(\text{NO}_3)_2 \cdot 6 \text{H}_2\text{O}$ in the ratio 2 : 3 and crystallizing the resulting mixture from aqueous solution; the crystals came down readily as thick plates. On closer examination, they were found to be deliquescent; as a consequence they were sealed in special Lindemann capillaries for X-ray photography.

Oscillation and Weissenberg photographs about the hexagonal and rhombohedral axes revealed an interesting feature; the observed reflexions hkl were all 'even, even, even' or 'odd, odd, odd'; of these 'odd, odd, odd's were, in general, very weak while the 'even, even, even's were consistently strong. This would suggest that the substance crystallizes in the 'face-centred' lattice,

In view of the fact that the strong diffraction intensities could, with good approximation, be attributed to the heavy atoms (since the scattering power of Mg, N and O is very small compared to La) the lattice formed by the Lanthanum atoms were deduced primarily from the strong layer-line separation on the oscillation photographs along the hexagonal 'a' and 'c' axes as :—

$$\left. \begin{array}{l} a = 10.91 \text{ \AA} \\ c = 17.35 \text{ \AA} \end{array} \right\} \text{hexagonal lattice.}$$

$$\left. \begin{array}{l} a = 8.53 \text{ \AA} \\ \alpha = 79.5^\circ \end{array} \right\} \text{rhombohedral lattice.}$$

Moreover, the angle between the hexagonal c-axis and the rhombohedral cell-edge was found to be 47.3° .

The lattice parameters were confirmed by the oscillation and Weissenberg photographs along the rhombohedral axis which gave the values :

$$a = 8.55 \text{ \AA}; \quad \alpha = 79.8^\circ.$$

It therefore seemed reasonable to conclude that the Lanthanum atoms lie on a rhombohedral lattice with a unit cell of side 8.54 \AA and interaxial angle of 79.7° .

However, the oscillation photograph about the rhombohedral axis showed intermediary weak layers corresponding to an 'identity period' of 17.1 \AA . At this stage, the density was determined by the method of 'flootation' which gave a value of 1.95 g. cm.^{-3} (at 20°C.); this seemed to require 4 molecules in the unit cell taking into account the weak odd-layers as well.

In view of the fact that each molecule is essentially comprised of 77 atoms (2 La, 3 Mg, 12 N and 60 O's; excluding H's) it seems advisable to attempt a three-dimensional analysis to elucidate the structure fully. This entails the collection of the 'intensity data' for all the possible layers (15) with equi-inclination angles less than 40° , around the rhombohedral axis. Part of the Weissenberg data, viz., for the zero, 1st, 2nd and 3rd layers have already been collected. The details of the analysis will be published elsewhere.

Physics Department,
Lucknow University,
Lucknow, December 22, 1960.

S. N. DUTTA.

1. Groth, P., *Chemische Kristallographie*, 1908, **2**, 156.
2. Cooke, A. H., Duffus, H. J. and Wolf, W. P., *Phil. Mag.*, 1953, **44**, 623.

**THE SEPARATION OF URANIUM
FROM CRUDE SODIUM-DIURANATE
BY PHOTOLYSIS**

THE application of the photolytic method¹⁻³ for the recovery of uranium from the commercial sample of sodium-diuranate is presented in this note.

The crude sample of diuranate was first treated with nitric acid (1:1) over a sand-bath with constant stirring. Filtration was carried out after dilution, when the residue became gelatinous and did not go into solution any further. The filtrate was made up to a fixed volume and was used as stock solution. Definite volumes of the stock solution were taken for the determination of the uranium content by two different methods, *viz.*, by extraction with ethyl ether and by the photolytic method. The extraction with ethyl ether was carried out according to the procedure followed by E. Peligot.⁴ The amount of uranium obtained by the ether extraction was taken as the standard for comparison with the product recovered from the photolytic process. In the photolytic separation, ammonium-bifluoride was first added to an aliquot of the stock solution, when the insoluble metal fluorides were filtered off. The pH of the solution was next adjusted to 2.5 after which alcohol was added to the extent of 20% by volume. The solution thus prepared was exposed to sunlight for 5-6 hours. The precipitated fluoride complex⁵ of uranium was filtered off and analysed in the manner described previously (*loc. cit.*). Uranium recovered by the two methods (Table I) is almost the same

TABLE I
*Recovery of uranium by single and double
stage photolysis*
Weights in mg.

Recovery from ether extract calculated as U ₃ O ₈	Oxide obtained from the product	Jone's reductor value calculated as oxide	Percentage of yield	Percentage of purity
2.030	2.040	2.032	100	99.61
(2.030)	(1.990)	(1.992)	(98.04)	(100)
2.028	2.038	2.027	100	99.47
(2.028)	(1.986)	(1.982)	97.92	(100)

Note. Figures in brackets are for double stage photolysis.

except for the fact that the product obtained by single stage photolysis is of 99.5% purity. To increase the purity, the photolysis was carried out for a second time after dissolving the fluoride complex in dilute nitric acid. The data for the product of two-stage photolysis recorded

in brackets show that the uranium obtained is chemically pure. The recovery of uranium after the second stage photolysis is about 98%; and the filtrate obtained containing 2% of the uranium can be used with the fresh sample of crude diuranate thus avoiding any loss of uranium.

The photolytic method outlined above offers an alternate procedure to the standard ones in practice for the separation of uranium in a chemically pure state, as it involves extremely simple operations and also as it utilises sunlight available in abundance throughout the year in our country.

Ravenshaw College,
Utkal University,

D. PATNAIK.
K. SINGH.

Cuttack-3, September 22, 1960.

1. Singh, K., Sahoo, B. and Patnaik, D., *Proc. Ind. Acad. Sci.*, 1959, **50 A**, 129.
2. — and Patnaik, D., *Ibid.*, 1959, **50 A**, 358.
3. —, Sahoo, B. and Patnaik, D., *J. Sci. Industr. Res.*, 1960, **19 B**, 31.
4. Peligot, E., *Ann. Chen. Phys.*, 1842, **5**, 5.
5. Sahoo, B. and Patnaik, D., *Curr. Sci.*, 1959, **28**, 195.

SYNTHESIS OF 4:5-DIHYDROXY-COUMARIN: A RARE OBSERVATION OF TOTAL γ -SUBSTITUTION IN RESORCINOL

MENTZER and Vercier¹ carried out the thermal condensation of phenols with substituted malonic esters and obtained 3-substituted-4-hydroxy-coumarin derivatives. It is now observed that when the same reaction is carried out in refluxing diphenyl ether corresponding 3-substituted-4-hydroxy-coumarin derivatives are obtained in good yields.

When resorcinol is condensed with ethyl methylmalonate it furnishes 3-methyl-4:7-dihydroxycoumarin as obtained by Mentzer *et al.* But when it is condensed with ethyl benzylmalonate in refluxing diphenyl ether, 3-benzyl-4:5-dihydroxycoumarin, m.p. 259-60°C. (Found: C = 71.99, H = 4.56; C₁₆H₁₂O₄ requires C, 71.64, H, 4.48%) is obtained in good yield. This compound underwent debenzylation when heated with anhydrous aluminium chloride at 200°C. for 15 min, to give 4:5-dihydroxycoumarin, m.p. 221°C. The structure of this compound was confirmed by direct comparison with an authentic sample of 4:5-dihydroxycoumarin prepared according to the method of Desai and Sethna.² Recently Vallet and Mentzer³ carried out the above condensation and obtained 3-benzyl-4:7-dihydroxycoumarin, m.p. 245°C. This is a rare

observation in which total γ -substitution in resorcinol has taken place without the use of condensing agent and furnishes an easier method for the synthesis of 4:5-dihydroxy-coumarin. Details of the condensation of phenols with substituted malonic esters in refluxing diphenyl ether will be published elsewhere.

Author's thanks are due to Prof. S. M. Sethna for his valuable guidance and help and also to Shri S. S. Lele for carrying out the micro-analysis.

Chemistry Department, K. N. TRIVEDI.
Faculty of Science,
Baroda-2, October 21, 1960.

1. Mentzer C. and Vercier, P., *Compt. rend.*, 1951, 232, 1674.
2. Desai, N. J. and Sethna, *J. Org. Chem.*, 1957, 22, 388.
3. Mentzer, C. and Vallet, *Compt. rend.*, 1959, 248, 184.

A NOTE ON THE FATTY OIL OBTAINED FROM *NIGELLA DAMASCENA* SEEDS

Nigella damascena L. (Natural Order : Ranunculaceæ; English : Damaskfennel; German : Türkischer Schwarzkümmel) was cultivated in Central Europe as far back as 16th century. The plant has its habitat in the Mediterranean regions and in Asia Minor.¹ The ripe seeds of the plant which are black in colour were earlier used in these countries as a household remedy. In homeopathy a tincture² prepared from the ripe seeds by percolation finds application as a remedy against catarrhal inflammations of liver and intestines. The seeds are also said to be effective as carminative, emmenagogue as well as anthelmintic. The plant grows wild and it also serves as a favourite garden flower. It is not found in India, though a closely related species *Nigella sativa* L. (Hindi : Kalonji, Kalajira) is cultivated in this country and used as a spice.³ A search made into the past literature on the chemical investigation of the seeds of *N. damascena* revealed that the drug contained an alkaloid Damascenine ($C_{10}H_{13}NO_3$), most of which is present in testa, a saponin type of glycoside ($C_{20}H_{33}O_7$) called Melanthine, and a blue fluorescent essential oil.⁴ During the course of investigations carried out at the University of Halle-Wittenberg (Germany) on the biochemical^{5,6} and pharmacological aspects of the plant it was found that large proportion of fatty oil was present in the seeds which may possibly find some application in industry. The

fixed oil appears hitherto not to have been chemically characterised as per literature available.

A detailed analysis carried out on several samples of the drug procured from different sources showed that it contained (average values) 7.82% moisture (based on dry weight), and 3.9% total ash (based on dry weight) while 0.14% of the total ash comprised its acid insoluble portion. The extraction of powdered seeds (seeds supplied by Deutscher Saatguthandelsbetrieb—Germany) with petroleum ether (B.P. 30–50° C.) in a soxhlet yielded a fatty oil content of 43.5%, based on the weight of air-dried drug. The yellowish-brown oily liquid possessed an aromatic odour and exhibited an intense blue fluorescence under filtered ultraviolet light. On keeping it for a long time it deposited a solid white mass. The following constants were determined employing the usual methods in order to chemically characterise the fatty oil thus obtained :—

1. Specific gravity	0.919 at 22° C.
2. Congealing point (Pharm. Germ. 6th). -3° to -4° C.	
3. Refractive index: (Zeiss Refractometer)	1.470 at 20° C.
4. Saponification value	193
5. Acid value	59.7
6. Acid number	106.4
7. Ester value	133.3
8. Iodine value (Kaufmann)	116.18
9. Butyric acid value	1.26
10. Reichert-Meissl value	2.50
11. Polenske value	0.35
12. Unsaponifiable	1.88%
13. Glycerine content (calculated) ..	7.29%

Percentage of total fatty acids contained in the oil was 97.08, while the percentage of free fatty acids amounted to 30.03.

From the above data it is clear that the fatty oil obtained from the seeds of *N. damascena* has an abnormally high acid value, though in most of the other constants it compares well with those of cotton-seed oil.⁷ The seeds of *N. damascena* have been shown to contain Lipase,^{8,9} the presence of which might explain for the unusually high acid value of the oil. It is inferred that the fatty oil of the drug can be grouped under semi-drying oils and could possibly be employed in the soap industry. Further work in regard to the determination of the exact composition of fatty acids is now in progress and will be reported in due course.

My grateful thanks are due to Prof. K. Mothes, Director, Pharmacognostical Institute, University

of Halle-Wittenberg (Germany), for his keen interest in the work.

Division of Pharmacy, MOHAN L. VISHIN.
Birla College of Pharmacy & Science,
Pilani (Rajasthan), October 25, 1960.

1. Hoppe, H. A., *Handbuch der pflanzlichen und tierischen Rohstoffe*, 7th Edition, Hamburg, 1958.
2. *Homöopathisches Arzneibuch*, 2nd Edition, Berlin, 1950.
3. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glssary of Indian Medicinal Plants*, Council of Scientific and Industrial Research, New Delhi, 1956.
4. Vishin, M. L., *Ph.D. Thesis*, University of Halle, 1960.
5. Hannig, E. and Vishin, M. L., *Planta Medica*, (Stuttgart), 1960, 8, 183.
6. Vishin, M. L., et al., *Nature (Lond.)*, 1960 (in press).
7. *British Pharmacopoeia*, The Pharmaceutical Press, London, 1958.
8. Tietz, N., *Biochem. Z.*, 1954, 325, 123.
9. Ullmann, E., *Pharmazie*, 1959, 14, 57.

A STUDY OF THE ROCKS AT PANDAVA FALLS IN PANNA STATE, M.P.

PANDAVA Falls is situated nearly seven miles away from Panna township on Chatterpur road between the latitude 24° 45' and longitude 80° 5', at a mean altitude of 874 ft. above sea-level.

F. R. Mallet mapped this area in detail and came to the conclusion that the rocks belonged to Kaimur Series. Just below the fall we come across massive rock having fine matrix. It contains a considerable amount of pebbles of varying shapes and sizes, majority of these being large in size. These pebbles are mostly elongated, but the matrix in which they are embedded is compact and seems to have been metamorphosed to some degree. Undoubtedly some pebbles are lens-shaped and exhibit rough orientation but the feature of polishing is seldom prominent.

Dubey and Chaudhary¹ while working in Sone and Ken valley respectively concluded that Central India suffered glaciation in the late pre-cambrian times together with Australia, China and S. Africa. Mathur² contradicted this view and proved that the mere presence of fresh-Feldspars in the matrix is no evidence of glaciation unless there are other supporting features. Auden³ also rules out the possibility of glaciation in this period.

Ahmed,⁴ while agreeing that the rocks are Kaimurs, has tried to attribute glacial origin to them merely on account of the fact that it con-

tains large boulders in the fine matrix with no evidence of sorting or bedding.

This formation is however overlain by a thin band of conglomerate which passes upward into what is considered as varvites by some advocates of glaciation. I can safely say that it is not varvite but thin-bedded sandstone, as there is no possibility of getting varvites under Fluvial conditions. Close study shows that this layering and friable nature are the outcome of the climatic fluctuations in that period. This thin-bedded sandstone is further overlain by compact sandstone which shows occasional occurrence of ripple marks and rain-drop impressions and has got practically horizontal dip.

Barrel regarded the old Red sandstones of Britain as Fluvial deposits formed along flood plains in intermontane basins, subject to seasonal rainfall and semi-arid conditions. These characters are similar to those found in Kaimur sandstones and hold good for this formation as well.

I therefore regard that these rocks below the Pandava Falls were deposited under fluvial conditions and belong to Kaimurs. And this so-called tillite is nothing but Breccia deposited under fluvial conditions which marks an unconformity between Kaimurs and underlying rocks.

H. B. SAXENA.

Dept. of Geology, C.S.I.R. Research Fellow.
Aligarh Muslim University,
Aligarh, December 19, 1960.

1. Dubey, V. S. and Chaudhary, M. S., *Curr. Sci.*, 1952, 21, 331.
2. Mathur, S. M., *Ibid.*, 1954, 23, 7.
3. Auden, J. B., *Mem. G.S.I.*, 62.
4. Ahmed, F., *Curr. Sci.*, July 1955, 24, 231.

EFFECT OF LUCERNE SUPPLEMENT TO THE RICE DIET ON CIRCULATING HAEMOGLOBIN AND PLASMA PROTEINS OF RATS*

SUBRAHMANYAN AND SUR^{1,2} reported that the rate of growth of rats receiving the poor rice diet increased three-fold when desiccated lucerne (*Medicago sativa* Linn.) leaf flour was included in the diet at 10 or 4% levels. Considering the amount of supplement fed, the increase in growth rate was remarkable. Preliminary trials showed that although the animals in the two groups grew at very different rates, there was not much difference in the R.B.C. count and haemoglobin concentration in the blood of the two groups of animals. It was of interest therefore to study the effect of

erne supplements on the blood volume and total circulating haemoglobin and plasma proteins. Two groups of freshly weaned rats (4 males & 4 females in each group), weighing 40-50 g. comparable with respect to age, weight, sex & litter, were fed *ad libitum* for a period of 6 weeks on (i) the poor rice diet and (ii) the same diet in which rice was replaced to the extent of 4% by an equivalent quantity of dry lucerne leaf flour. At the end of the experimental period, blood was drawn from the tail and haemoglobin estimated by the acid haematin method using photoelectric colorimeter. Total volume was next determined by the Evans blue injection method as described by Metcalf and Favour.³ 0.3 ml. of the dye solution was injected through the right jugular vein after 3 minutes, blood was withdrawn from abdominal vein. After determining haematocrit, 0.2 ml. of plasma was diluted to 5 ml. in isotonic saline solution and the concentration of the dye estimated in a photoelectric colorimeter. Total nitrogen in plasma was determined in 0.1 ml. plasma samples by the o kjeldahl method. As sufficient blood could not be drawn from two female rats in group I, data obtained with six animals in each group are presented in Table I.

TABLE I

Effect of lucerne supplement on blood volume and circulating haemoglobin and plasma proteins of rats

	Poor rice diet (Group I)	Poor rice diet + 4% lucerne (Group II)	Significance
weight (g.)	.. 76	121	..
haemoglobin	15.1 ± 0.51	15.3 ± 0.24	..
100 ml. blood	923 ± 22.7	926 ± 15.3	..
plasma nitrogen (1/100 ml. plasma)	22.7	15.3	
haemocrit	.. 41 ± 1.5	43 ± 1.5	..
total volume	2.9 ± 0.17	3.8 ± 0.21	†
/100 g. body wt.)	5.0 ± 0.32	6.6 ± 0.43	*
volume (100 g. body wt.)	0.76 ± 0.062	1.01 ± 0.074	*
circulating Haemoglobin (100 g. body wt.)	27.1 ± 1.14	34.8 ± 1.97	†
Plasma protein (mg./100 g. wt.)	1.14	1.97	

Significant at 5% level. † Significant at 1% level.

It would be seen from Table I that there is no difference in the concentration of haemoglobin and plasma nitrogen in animals of both groups. However, in the case of animals receiving lucerne supplements, there is a significant

increase in plasma and blood volumes (per 100 g. body weight) with a consequent increase in total circulating haemoglobin and total circulating plasma proteins per 100 g. body weight. In the case of rats receiving the poor rice diet, the circulating haemoglobin and plasma proteins are lower. This is not apparent from their concentration owing to decrease in blood volume.

Author's thanks are due to Dr. V. Subrahmanyam, Director, Central Food Technological Research Institute, Mysore, for valuable advice during the course of the work.

G.S.V.M. Medical College,
Kanpur, October 7, 1960.

B. K. SUR.

This work was done by the author in the Central Food Technological Research Institute, Mysore.

1. Subrahmanyam, V. and Sur, B. K., *Ind. J. Med. Res.*, 1949, 37, 319.
2. Sur, B. K. and Subrahmanyam, V., *Curr. Sci.*, 1954, 23, 188.
3. Metcalf, J. C. and Favour, E., *Amer. J. Physiol.*, 1944, 141, 695.

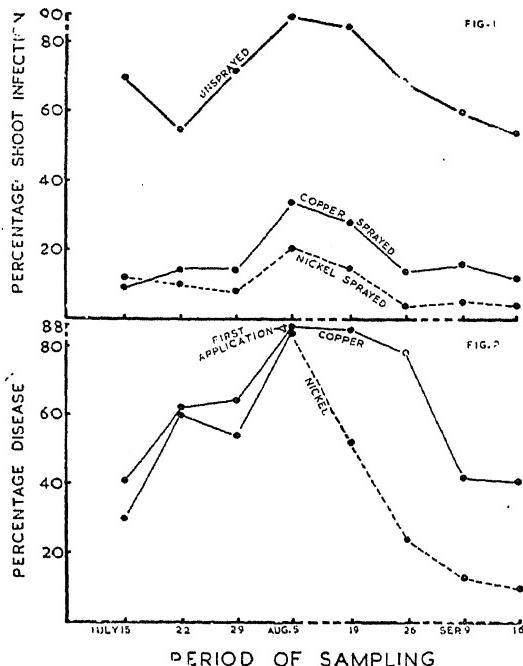
APPLICATION OF NICKEL CHLORIDE TO TEA PLANTS (*CAMELLIA SINENSIS*) AND CONTROL OF BLISTER BLIGHT

A LEAF disease of tea plants incited by *Exobasidium vexans* Massee, commonly known as blister blight, affects an area over 150,000 acres in Southern India and, indeed, is perhaps the most serious single problem in tea cultivation. Ever since the outbreak of the disease in 1946, numerous inorganic and organic fungicides have been tested¹⁻³ but none gave disease control superior to that achieved with copper fungicides. Similar results were also obtained in Ceylon.⁴ Method in vogue for blister blight control involves protective spraying (or dusting) with copper fungicides at 7-10 day intervals. Consequent on the striking success recently reported with nickel compounds against cereal rusts,^{5,6} both as protective as well as eradicative fungicides, field trials were carried out with nickel chloride to test its efficiency in controlling blister blight and results are reported here.

The experimental layout was of a randomized block design with quadruplicate plots, each with ten tea bushes, in a treatment. A proven cuprous oxide (Perenox) and nickel chloride hexahydrate were sprayed at the rate of 6 oz. in 15 gallons of water per acre at 7-day intervals. Pressure retaining knapsack sprayers fitted with a low volume nozzle were employed and fungicide application followed soon after plucking. In two other treatments the plots

were allowed to develop a very heavy initial infection, after which in one treatment copper oxychloride at 6 oz. and in the other nickel chloride at 3 oz. per acre were sprayed. Disease assessment was made weekly by determining the number of shoots infected in a lot of 100, selected at random from the total number of shoots plucked in each plot and from this percentage disease calculated with reference to the control.

With the exception of the first sampling, percentage shoot infection was throughout lower in nickel chloride than in the cuprous oxide treatment (Fig. 1). Infection was 8-13% higher



Figs. 1 and 2 showing the influence of nickel spray on blister blight disease of tea plants. Fig. 1 gives percentage shoot infection in unsprayed, copper and nickel sprayed plots. In Fig. 2 the rate of decline of percentage disease in nickel-treated plots, which had initially high blister blight infection, is compared to that in copper treated plots.

in cuprous oxide treatment when compared to nickel chloride in the last four assessments. The metallic content of the two fungicides was 50% copper and 25% nickel and, therefore, at the concentrations used, 3 oz. copper and 1.5 oz. nickel were applied per acre. In the other experiment intended to test the eradicative activity of nickel, 3 oz. nickel chloride (0.75 oz. nickel) sprayed on plots with an average initial infection of 84% reduced the disease to 24 and 13% after 3 and 5 weekly applications, respectively.

In a parallel treatment 6 oz. of copper oxychloride (3 oz. copper) failed to give such striking disease control (Fig. 2). An important point emerging out of these results is that nickel in concentration equivalent to one-fourth that of copper seemed to be markedly superior to copper in controlling blister blight. Reports from tea tasters indicate that nickel chloride does not taint tea. Tests with other nickel salts are being carried out and details will be published elsewhere.

Tea Experiment Station, C. S. VENKATA RAM. Devarshola, The Nilgiris, S. India, September 19, 1960.

1. de Jong, P., *UPASI Sci. Dep. Tea Sect. Bull.*, 1956, 15, 2.
2. Jayaraman, V. and Venkataramani, K. S., *Planters' Chronicle*, 1957, 52, 35.
3. Venkata Ram, C. S. and Jayaraman, V., *A.R. UPASI Sci. Dep. Tea Sect. Bull.* for 1959-60, 1960, 36.
4. Park, P. O. and Webster, B. N., *Tea Quart.*, 1956, 27, 14; Visser, T., Shanmuganathan, N. and Salanayagam, J. V., *Ibid.*, 1958, 29, 9.
5. Forsyth, F. R. and Peterson, B., *Plant Dis. Rept.*, 1959, 43, 5.
6. Keil, H. L., Frohlich, H. P. and Van Hook, J. O., *Phytopathology*, 1958, 48, 612; Peterson, B., Forsyth, F. R. and Lyon, C. B., *Ibid.*, 1958, 48, 655; Keil, H. L., Frohlich, H. P. and Glassick, C. E., *Ibid.*, 1958, 48, 600; Forsyth, F. R. and Peterson, B., *Ibid.*, 1959, 49, 1.

FOLIN-PHENOL REAGENT FOR THE MEASUREMENT OF LEAF PROTEINS

In an investigation of fractionation of leaf proteins, a suitable method of measuring protein contents of fractions was to be considered. Use of trichloroacetic acid to precipitate protein and further digestion with acid and nesslerization is the method of choice in most enzyme-protein studies, although a quite time-consuming one. However, where both rapidity and sensitiveness are needed (especially when replicated samples are to be studied) Folin-phenol reagent method is found more useful (Lowry *et al.*, 1951).

One main disadvantage of the Folin-phenol reagent method is that the colour developed is not strictly proportional to concentration, in all cases. It was therefore felt necessary to find out if a straight line curve relationship could be obtained with leaf proteins using this method. This was tested as below:

One gramme leaf tissue was homogenised in water, made to 50 ml. volume and filtered through four folds of cheese cloth. The filtrate was mixed well and 1, 2, 3, 4 and 5 ml. aliquots diluted to 50 ml. volume. After shaking well, 1 ml. of

each of the diluted leaf homogenate was taken in a test-tube to which 5 ml. of protein reagent (Folin) was added. The mixture was maintained at 37° C. in a water-bath. Later, 0.5 ml. of phenol reagent was added and shaken vigorously immediately. Again the mixture was maintained at 37° C. for 20 minutes. Optical density of blue colour developed was measured at the end of 20 minutes as early as possible, against reagent blank, at 650 m μ in the Beckman model B spectrophotometer. Concentration of protein was then calculated by referring to a standard curve prepared using pure casein solution. The instrument readings and the curve obtained by plotting concentration against optical density are given below respectively in Table I and Fig. 1.

TABLE I
Relationship between concentration of leaf proteins and optical density of the colour developed with Folin-phenol reagent

Concentration	Optical density at 650 m μ
1 ml. leaf homogenate	.. 0.035
2 do.	.. 0.0725
3 do.	.. 0.1100
4 do.	.. 0.1450
5 do.	.. 0.1780

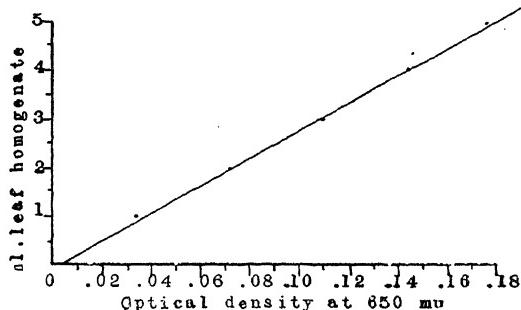


FIG. 1. Relationship between concentration of leaf proteins and optical density of the colour developed with Folin-phenol reagent.

The optical density of the blue colour developed is thus found to be linear with the concentration of leaf proteins. Several hundred measurements of leaf proteins were made using this method. Results have been quite satisfactory in all cases.

It is therefore suggested that the Folin-phenol reagent method holds good with leaf proteins and may be employed with advantage wherever similar studies are to be made.

(This work was done at the Utah State University, Logan: USA.)

Agricultural College, N. G. PERUR.
Dharwar, September 18, 1960.

1. Lowry, O H., Rosebrough, Niq. Farr A. L. and Randall, Rose, J., "Protein measurement with Folin-phenol reagent," *Jour. Biol. Chem.*, 1951, 193, 264.

A HÆMAGGLUTINATING STRAIN OF MIYAGAWANELLA CAUSING POLYARTHRITIS IN SHEEP IN INDIA

An apparently new disease entity polyarthritis in sheep was encountered accidentally in two out of a batch of 20 lambs, 4 to 6 months in age, purchased for experimental induction of virus pneumonia and kept under observation prior to artificial infection. The affected lambs showed involvement of joints and pyrexia (104-06° F.) that persisted for 4 to 6 days before manifestation of panarthritis and consequent lameness.

All the joints were swollen and acutely painful as the lambs resisted any physical manipulation. They became recumbent on the 4th day and both of them succumbed to the infection on the 7th day. Peripheral blood smears at the height of pyrexia showed no protozoa of pathogenic significance, while bacteriological examination of the joint fluids, heart blood and other tissues on blood agar and in serum broth yielded no micro-organism of aetiological importance. All attempts were made to isolate well-known microbial pathogens of arthritis like *Corynebacterium pyogenes*, *C. pseudotuberculosis*, *Erysipelothrix insidiosa*, and *Mycoplasma agalactiae* with entirely negative results.

A virus-like agent was recovered from the aspirated specimens of synovial fluids from the knee and hock joints of both the affected lambs through intraperitoneal inoculation into guinea-pigs. Macchiavello- and Giemsa-stained impression smears of synovial fluid and scraping smears of joint cavities showed typical intracytoplasmic inclusion bodies (Fig. 1).

On autopsy, all the internal organs showed generalised congestion but, otherwise, appeared normal. No virus could be recovered from pooled suspensions of liver, spleen, kidney, lungs and brain while prescapular and precrural lymph nodes, which were enlarged and hyperæmic, yielded the agent on intraperitoneal inoculation into guinea-pigs.

The virus, so isolated, has since been maintained by serial passages in guinea-pigs,

wherein it has undergone, so far, three sub-inoculations. The causal agent was found to belong to the Psittacosis-lymphogranuloma venereum group of viruses inasmuch as it (i) formed elementary bodies; (ii) was relatively sensitive to oxytetracycline and penicillin but not to streptomycin; (iii) was pathogenic for 7 to 8-day-old embryonating hen's eggs when inoculated via the yolk-sac route killing them

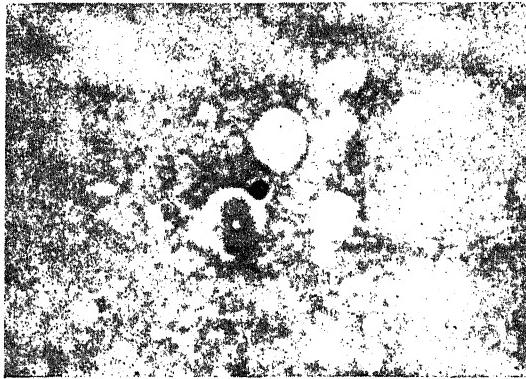


FIG. 1. Scrape-smear from the lining of joint cavity of an affected lamb showing intracytoplasmic inclusion body. (Macchiavello, $\times 1,000$.)

between 7th and 9th day; (iv) produced characteristic pathological changes, like sterile fibrinous peritonitis and splenomegaly, in adult guinea-pigs when they were destroyed on the 10th day following inoculation; and (v) showed cross-reaction to a titre of 1:32 to 1:64 in the complement-fixation test with the antisera against the Nagano strain of goat pneumonitis¹ and Shizuoka strain of bovine encephalomyelitis,² gifts of which were generously made to us by Dr. Susumu Ishii, Director, National Institute of Animal Health, Tokyo, Japan. It was found that sheep arthritis virus, at dilutions comparable with those of the other two suspensions,^{1,2} gave a full degree of fixation in the presence of both sera. Further tests showed that antibody reacting with all three virus preparations could be removed completely from both sera by absorption with a heated suspension of the new virus.

However, some differences were observed notably the refractoriness of mice to experimental infection by intraperitoneal, intracerebral and intranasal routes and susceptibility of the complement-fixing antigen prepared from this strain towards phenol³ and urea.⁴

The polyarthritis virus, when propagated in the allantoic cavity of 8-day-old embryonating eggs, proved capable of haemagglutinating mouse

erythrocytes, which property had till now been found to be associated only with *Miyagawanella* strains of avian origin.^{5,6} The virus had no action on the erythrocytes of any of many other species tested, viz., rabbit, guinea-pig, pigeon, chick, horse, cattle, buffalo, sheep and goat. The haemagglutination-inhibition (HI) and complement-fixation (C.F.) tests provided reliable methods for measuring antibody in the two naturally infected lambs before their death. Their sera collected on the 6th day gave titres of 1:256 to 1:512 in the HI and 1:64 to 1:128 in the C.F. tests against an antigen prepared from the homologous arthritis virus. The two samples of serum from infected lambs were found to fix complement to a similar extent with heated preparations of goat pneumonitis¹ and bovine encephalomyelitis² viruses, as in each case a serum titre of 1:64 was recorded. None of the other fifty healthy sheep (including 16 lambs from the same group) that were examined showed antibodies reactive in the above tests in their sera at levels of above 1:8.

Thus, the heat-stable antigen common to Psittacosis-lymphogranuloma group of viruses was readily demonstrated in the virus of polyarthritis of sheep, which should therefore be classified with this group.

Mice that received infective material from naturally affected lambs were found to be entirely hale and healthy after three weeks but, when their sera were collected on the 22nd day following infection and tested, they showed HI titres of 1:256 to 1:512 and C.F. values of 1:64 to 1:128 against the homologous virus antigen. Thus, it seemed justifiable to conclude that the mice suffered from an asymptomatic benign immunising infection with this virus strain.

As far as the authors are aware, this seemed to be the first report of its kind, as they were unable to trace any previous reference to isolation of a virus from cases of arthritis in sheep either in India or other countries.

Division of Pathology and P. G. PANDE.
Bacteriology, R. R. SHUKLA.
Indian Veterinary Res. Ins., P. C. SEKARIAH.
Mukteswar-Kumaon.
August 26, 1960.

1. Omori, T., Ishii, S., Harada, K., Ichikawa, O., Murase, N., Katada, M. and Araumi, W., *Exp. Rep. Govt. Exp. Stat. Anim. Hyg.*, Tokyo, 1953, No. 27, 109.
2. —, Kawakami, Y., Ishii, S., Ishitani, R., Harada, K. and Matumoto, M., *Jap. J. Exp. Med.*, 1954, 24, 257.

3. Nigg, C., *Science*, 1942, 95, 49.
4. —, Hilleman, M. R. and Bowser, B. M., *J. Immunol.* 1946, 5, 201, 259, 269.
5. Inaba, Y., Omori, T., Ishii, S. and Matumoto, M., *Jap. J. Exp. Med.* 1957, 27, 425.
6. Pande, P. G., Shukla, R. R. and Sekariah, P. C., *J. Insect. Dis.*, 1960 (In Press).

ON THE OCCURRENCE OF PELAGIC FISH SPAWN

IT is well known that the spawn of marine fishes usually occurs as individual eggs in the plankton and it is very rare to find large numbers of eggs collected together in a single mass. During the past ten years we have come across only three such spawns all of them similar and apparently belonging to the same species of fish. There are only two previous reported instances of such spawns from Indian waters. Nair (1952) described a metre long ribbon-shaped spawn from the plankton collected off Madras but he was not able to establish its identity. Padmanabhan (1957) described hollow tubular egg masses measuring 18" to 20" of *Antennarius marmoratus* from the laboratory tanks at Trivandrum. The only other account of a fish spawn mass is that of *Lophius piscatorius* described by Ehrenbaum (1905) from the North Sea which consisted of a number of eggs, each egg being enclosed in a capsule.

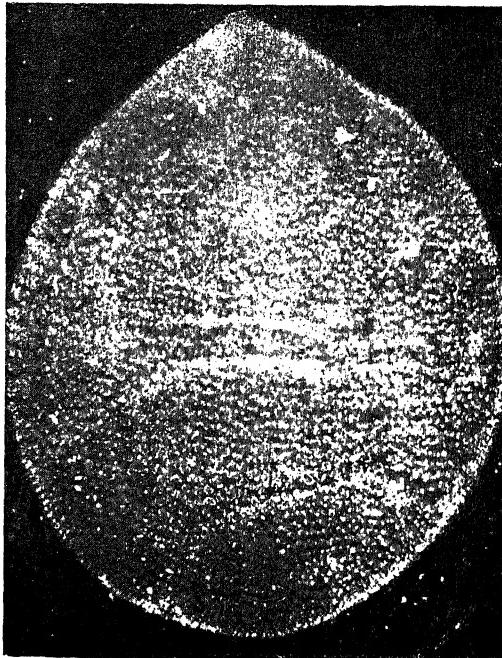


FIG. 1. Photograph of spawn mass

The three spawn masses described here were obtained from the surface plankton during the months of September and December 1958 and

January 1959. These are different from those described by Nair and Padmanabhan. The spawn mass (Fig. 1) was in the form of a hollow oval rubber balloon, measuring 6½ cm. in length and 4 cm. in breadth. There were nearly 2,000 eggs, each egg being enclosed in a separate capsule. The eggs (Fig. 2) were more or less

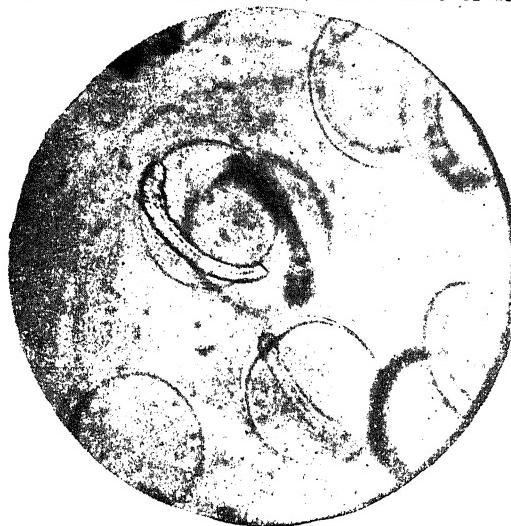


FIG. 2. Part of the spawn magnified.

oval in shape, measuring 1·6 mm. in length and 1·08 mm. in breadth. The yolk is unsegmented and an oil globule is absent. The eggs were in different stages of development. The spawn mass collected on 10th December 1958 was kept in clean sea-water and the larvae hatched out the next day. Most of the larvae survived for about four days after which they rapidly dwindled and only two survived for seven days.

The identity of the spawn mass could not be established as the hatchlings did not survive long enough to establish the larval characters necessary for identification. The paucity of adequate literature on such spawn masses also rendered it difficult to establish the identity of the spawn. It is, however, hoped that we may succeed in rearing the larvae successfully to an advanced stage and establish their identity if such spawn masses are again encountered at a future date.

Dept. of Zoology, P. N. GANAPATI.
Andhra University, N. SOLOMON RAJU.
Waltair, November 8, 1960.

1. Ehrenbaum, E., *Eier. Und. Larven. Von Fischen Nordisches plankton*. 1905, 146.
2. Nair, R. V., *Proc. Ind. Acad. Sci.*, 1952, 35 (5) B, 181.
3. Padmanabhan, K. G., *Bull. Central Res. Instt., Travancore University*, Trivandrum, 1957. 5 (1).

**GERMINATION OF GRAPE
(*VITIS VINIFERA* L.) HYBRID SEEDS
BY CHILLING**

IN grape-breeding considerable difficulty was experienced in the germination of hybrid seeds during 1959. An attempt to break the dormancy of the seeds of grape crosses was made at Hyderabad¹ by subjecting them to cold treatment at 0°C. in a refrigerator for one month prior to sowing but only 4·6 and 5·8% germination could be obtained in 1952-53 and 1953-54, respectively. Flemion,² and Scott and Ink³ have reported that an after-ripening period of three

seeds sown, germinated and percentage of germination is given in Table I.

It is evident from Table I that most of the hybrid seeds stored at the room temperature (70°-98°F.) did not germinate at all. On an average the grape seeds chilled at 40°F. showed a higher germination percentage than the seeds stored at 35°F.

Thus, a satisfactory germination of grape seeds can be obtained by chilling them at 40°F. for a period of three months and thereby, a larger hybrid population can be raised in hybridization programmes.

TABLE I
Germination of grape hybrid seeds three months after storage

Sl. No.	Hybrid seeds of the cross	Seeds chilled at 35°F. for 3 months			Seeds chilled at 40°F. for 3 months			Seeds stored for 3 months at room temp (70°-88°F.)		
		No. of seeds sown	No. germina- ted	% germina- tion	No. of seeds sown	No. germina- ted	% germina- tion	No. of seeds sown	No. germina- ted	% germina- tion
1	Saharanpur No. 2 × Dehiadun	55	22	40·0	70	20	28·6	63	..	..
2	" × Pearl of Csaba	50	33	66·0	50	29	58·0	29	..	..
3	" × Motia ..	30	161	48·8	350	184	52·6	246	4	1·62
4	" × Rose of Pen ..	50	15	30·0	50	31	62·0	13	..	..
5	" × Muscat White	60	30	50·0	60	36	60·0	64	21	32·81
6	" × Black Round	150	56	37·3	150	82	54·6	100	9	9·0
7	Motia × Saharanpur No. 2	25	7	28·0	25	14	56·0	11	..	..
8	" × Pearl of Csaba	50	8	16·0	50	8	16·0	18	..	..
9	" × Rose of Pen ..	40	27	67·5	40	10	25·0	24	..	..
10	" × Black Round	100	53	53·0	100	55	35·0	39	..	..
11	Muscat White × Saharan- pur No. 2	40	5	12·5	40	11	27·5	24	..	..
12	" × Motia ..	50	18	36·0	50	30	60·0	50	..	..
13	Rose of Pen × Saharanpur No. 2	40	13	32·5	45	10	22·2	62	..	..
14	Black Round × Saharanpur No. 2	50	12	24·0	50	4	8·0	26	..	..
Mean germination per- centage		..	..	38·7 ±9·7	..	..	40·4 ±11·0	..	..	41·10 +5·12

months at a cold temperature (5°C.) is essential for the optimum germination of grape seeds. A preliminary experiment was, therefore, laid out at the Horticultural Research Institute, Saharanpur, for the germination of grape crosses by seed-chilling.

The hybrid seeds of fourteen grape crosses were fully dried after extraction. Seeds of each cross were divided in three portions and kept in stoppered glass phials. The three lots were stored at the room temperature (70°-80°F.) and in the cold storage at 40°F. and 35°F. respectively. After three months, the seeds were taken out and sown in earthen pans.

The germination of the seeds of each lot was recorded separately at weekly intervals from December 1959 to April 1960. The number of

Horticultural Research Inst.,
Saharanpur, September 5, 1960.

S. N. SINGH.

1. Anonymous, *Final Consolidated Rep. Hyderabad Fr. Scheme*, 1941-57.
2. Flemion, F., *Contr. Royce Thompson Inst.*, 1937, 9, 7.
3. Scott, D. H. and Ink, D. P., *Proc. Amer. Soc. hort. Sci.*, 1930, 56, 134.

**AN APETALOUS MUTATION IN TORA
BROWN SARSON (*BRASSICA CAM-
PESTRIS* VAR. *BROWN SARSON*)
AND ITS INHERITANCE**

A MUTANT in which the whorl of petals was missing was isolated by the author in his breeding material of *tora brown sarson* (self-fertile) at the Government Research Farm, Kanpur, in

1957-58. Earlier Ramanujam (1940) had reported an apetalous mutant in turnip.

DESCRIPTION OF MUTANT

The brown sarson apetalous mutant was like the apetalous mutant of turnip with regards to apetaly but differed from the latter in other floral characters. Instead of the usual 6 tetrodynamous stamens characteristic of the cruciferæ family, the mutant had only 4 stamens in about 80% flowers on a plant. Of the remaining 20% flowers some had five and others six stamens but instead of the usual 4 long and 2 short stamens all the stamens were nearly of the same length or the 5th and 6th stamens were only very slightly smaller than the 4 long stamens. In these flowers which had only 4 stamens, either 2 stamens appeared to be completely missing or 2 stamens out of 4 were double due to their fusion with their neighbouring stamens. In some cases only the filaments were joined together. In others the anthers were also fused either only at the base or nearly up to the tip of the anthers. The pod and seed-setting were quite normal in the mutant.

INHERITANCE

In order to study the inheritance of the apetalous mutant, it was crossed with a normal variety. The F_1 was grown in 1957-58 at the PIRRCom Centre, Kanpur. Normal was found to be dominant over apetalous in F_1 .

The F_2 population segregated into 275 normal and 77 apetalous plants. This gives a good fit to 3:1 ratio as the chi-square value is not significant. (Chi-square 1.433 P. between 0.30 and 0.2.) The floral character of the mutant with regards to the morphology of the stamens was, however, found to be completely associated with apetalous condition. In F_2 all the plants with normal petals possessed the usual six tetrodynamous stamens while the apetalous plants had stamens like the original apetalous mutant. It appears that apetaly and reduction in number of stamens is due to the pleiotropic effect of the same gene which causes complete loss of petals as well as reduction in the number of stamens.

Regional Research Centre, DHARAMPAL SINGH.
(Oilseeds and Millets), I.C.A.R.,
PIRRCOM, Kanpur, September 12, 1960.

1. Ramanujam, S. "An apetalous mutation in turnip (*Brassica campestris*)," *Nature*, 1940, 145, 552.

FORMATION OF RED ROT ACERVULI ON THE NODES AND WITHIN THE TISSUES OF DISEASED CANES

THE acervuli of red rot fungus appear as dark and minute dots on the straw-coloured central region of the lesions on the upper surface of the midribs of cane leaves. They are also formed on the rind of shrivelled and dried-up canes affected with red rot.^{1,2}

In varietal susceptibility trials carried out at this Institute against *Colletotrichum falcatum* Went, strain 'D', two hitherto unreported observations were made. One was the development of acervuli on the root-primordia of inoculated canes, and the other, the production of pink spore masses of red rot fungus within the diseased stalks.

The acervuli were observed on 13 varieties, viz., Co. 951, Co. 963, Co. 971, Co. 997, Co. 1055, Co. 1063, Co. 1073, Co. 1161, Co. 1184, Co. 1218, Co. 1235, Co. 1302 and Co.S. 510, out of 234 under trial. These were produced well before the inoculated cane stalks dried up and shrivelled. The soft black masses of acervuli were confined almost entirely to the primordia of roots, giving the impression that the root primordia themselves had been transformed into acervuli (Fig. 1). All the root primordia on



FIG. 1. Node of Co. 963 showing acervuli over root primordia.

a root band did not bear acervuli. Some of the primordia were unaffected. In varieties Co. 963 and Co. 997 the acervuli on the root primordia were covered with pink spore masses. It is likely that in other varieties also, pink spore masses appear during early stages.

Bits of these acervuli were transferred to oat meal agar medium; they produced typical cultures of strain 'D' of *C. falcatum*.

The acervuli on the midrib lesions and rind of dried-up diseased canes have not been observed to be covered with pink masses of conidia. Moreover, these acervuli are small while those observed on root primordia are much larger and may be releasing a greater number of spores. Should these be produced in nature, the acervuli of root primordia may be a far more potent source of dissemination of red rot than those on the rind and midrib lesions.

Regarding the production of fungus spores within the canes, it is thought likely that spores are formed only after the cane stalks are altogether dried up and almost completely hollow. In our trials of 1959-60, acervuli with pink masses of conidia were found inside the stalks of inoculated canes of 13 varieties, viz., Co. 947, Co. 963, Co. 997, Co. 1006, Co. 1024, Co. 1029, Co. 1033, Co. 1079, Co. 1142, Co. 1223, Co. 1235, G. 9195 and G. 9719. The reddening of the tissues was confined to a narrow central core, excepting in Co. 997 and Co. 1235 in which the entire cross-section was reddened. None of the canes however, dried up or was shrivelled. It therefore appears possible that fungus spores produced at such an early stage may get carried along with vascular passages to the extent of continuity of the latter and thus be responsible for quicker spread of infection.^{2,3}

We are grateful to Sri. R. R. Panje, Director, Indian Institute of Sugarcane Research, Lucknow, for valuable suggestions.

Indian Institute of Sugarcane V. B. SINGH.
Research, KISHAN SINGH.
Lucknow, October 3, 1960.

-
1. Abbot, E. V., *U.S.D.A. Tech. Bull.*, 1938, 651.
 2. Atkinson, R. E., *Int. Soc. Sugarcane Tech. Proc., 6th Conf.*, 1939, 684-92.
 3. Tiwari, M. M., *Thesis for Assoc. I.A.R.I.* (Unpublished), 1957.
-

TWO FUNGI CAUSING SPOILAGE OF REFRIGERATED POULTRY MEAT

RECENTLY we received samples of fungal infested poultry meat from the Principal of the Veterinary College, Madras. These samples were taken from spoiled meat pieces stored under refrigeration at 5° C. for over 14 days. They were found affected by two types of fungi. One was characterized with specks of raised cottony white growth on the surface, while the other was dull-brown in colour, with long threads of mycelium spreading sparsely over the meat. Both the organisms were isolated, brought into pure culture and their characters studied.

The two fungi could grow well on liver extract and yeast extract agar media and moderately well on potato dextrose agar.

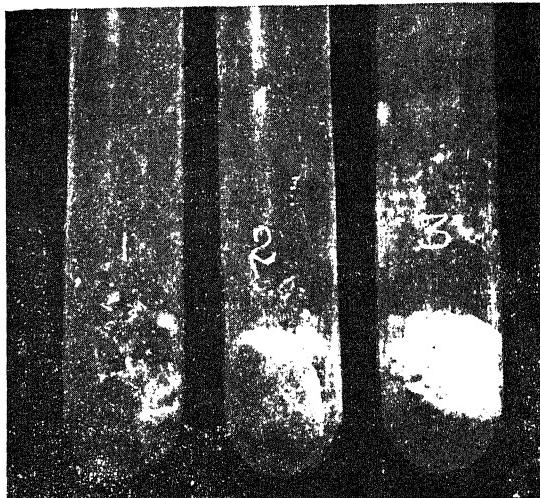
The growth at room temperature (28-30° C.) was very meagre and slow, but when the cultures were incubated at 5-8° C. profuse growth was obtained in both cases.

The white fungus gives cottony aerial mycelium on the agar slants. On microscopic examination, the hyphae are found hyaline, thin-walled, narrowly septate, with numerous fat-like globules, and 2.8 to 3.5 μ in thickness. Conidia are borne singly on conidiophores which are either terminal or formed on short, slender branches. Only macroconidia are observed. They are fusiform, hyaline, thin-walled, crenulate, 1 to 5 septate, mostly 3 septate, and measure 8.0-14.0 \times 3.0-4.1 μ . Based on these characters the fungus is identified as *Microsporum* sp.¹

The second fungus grows mostly submerged in the agar media, but with a few silky dull-brown aerial hyphae sparsely spreading on the surface. It does not produce any soluble pigment in any of the media tested. On microscopic examination the hyphae are found hyaline, 2.8 to 3.5 μ thick, and broadly septate. Numerous conidiophores are found which are stout, simple or branched, septate with inflated columella-like structures which are either terminal or intercalary. These structures measure 25 to 40 μ in diameter, are thin-walled and hyaline and bear the head of conidia acropetally on their surface. The conidia are ovoid to ellipsoid, thin-walled, smooth, light-brown in colour and measure 3.6-6.2 \times 2.4-4.7 μ . The fungus is identified as a species of *Gonatorrhodiella*.¹

To examine the harmful effect of the fungi on meat, slices of fresh chicken and lamb meats were prepared, washed well in sterile water, placed in boiling tubes, plugged with cotton wool and steamed for 30 minutes in an autoclave. Pure cultures of the fungi were inoculated into the tubes and incubated at 5-8° C. in a refrigerator and also at room temperature. There was very little or no growth of the two fungi at room temperature, but at 5-8° C. there was fluffy-white growth of *Microsporum* sp., and silky-brown growth of *Gonatorrhodiella* sp., covering completely the meat pieces (Fig. 1). When the meat pieces were examined after seven days' incubation, characteristic musty odour was noted in the inoculated tubes; the meat pieces were discoloured dull-brown and considerably softened, as against little or no change in the uninoculated pieces. In the case

of meat piece inoculated with *Microsporum* sp., besides softening of the tissues, dark-brown liquid collected at the bottom of the tubes, but not with *Gonatorrhodiella* sp.



FIGS. 1-3. Fig. 1. Uninoculated chicken meat. Fig. 2. Chicken meat inoculated with *Gonatorrhodiella* sp. Fig. 3. Chicken meat inoculated with *Microsporum* sp.

Of the two genera, species of *Microsporum* are known to be parasitic to man and animal, causing dermatomycoses.² The species under study probably had its origin from the poultry birds. *Gonatorrhodiella* sp., however, seem to have not been so far reported on poultry meat or any other animal substrata. These studies indicate the need for careful examination of the meat before and after storage at low temperatures under Indian conditions so as to avoid the danger of preserving and spreading the harmful micro-organisms.

Dept. of Agriculture, G. RANGASWAMI,
Annamalai University, R. VENKATESAN.
Annamalainagar (S. India),
September 2, 1960.

1. Barnett, H. L., *Illustrated Genera of Imperfect Fungi*, Burgess Publishing Co., Minneapolis, Minn., U.S.A., 1955.
2. Conant, N. F., Martin, D. S., Smith, D. T., Baker, R. D. and Colloway, J. L., *Manual of Clinical Mycology*, W. B. Saunders Co., Philadelphia, U.S.A., 1944.

BLIGHT OF FENNEL IN RAJASTHAN
I. Morphology and Identity of the Pathogen
FENNEL (*Foeniculum vulgare* L.), an important cash crop in Ajmer and Kota Divisions of the State, has been found to suffer severely from

a blight disease. The disease first appears in January on lower and older leaves of the plant as minute, angular, brown necrotic areas which later become larger and are covered with greyish-white erumpent growth (Fig. 1). The disease advances upwards and the linear and rectangular spots coalesce covering the entire stem, peduncles and fruits. Severely affected leaves shrivel and dry up. In plants affected in early stages, seed formation does not take place and in others seeds are shrivelled and blackened.



FIG. 1. A—healthy stem; B—Diseased stem of Fennel.

A popular account of the disease, attributed to *Cercospora foeniculi* Magn. was given in 1950 from Ajmer¹ and later Joshi² studied its symptoms, morphology and phenological relations. Sydow and Mc Rae³ believed *C. foeniculi* (first recorded from India by them from Harwan, Kashmir and Pusa, Bihar), to be merely a form of *Fusicladium depressum* (Berk. and Curt.) Sacc. Chupp⁴ could not find any resemblance of this *Cercospora* species with the characters generally attributed to *Fusicladium* and is of the opinion that *Ramularia foeniculi* described by Sibilia⁵ should also be classed as a species of 1-septate *Cercospora* better disposed off as *Didymeria*. Since the systematic position of the pathogen was uncertain, and since in recent years the disease assumed epiphytic form throughout the fennel-growing tract of the State (Ajmer, Kekri, Deoli, Malpura and Tonk), studies were undertaken by the authors.

The usual method of isolation, namely, plating the surface sterilized diseased bits of the plants, did not yield the fungus in culture. However, the conidia of the fungus readily germinated in water (Fig. 2, b) within 24 hours. To obtain the culture, single germinating conidium was

further transferred to P.D.A. 2% ; P.D.A. 5% ; fennel leaf extract added to P.D.A. ; fruit extract and dextrose agar ; carrot extract agar ; Czepek's agar and Richard's agar media with and without yeast ; Czepek's and Richard's

The morphological characters and size of the conidiophores and the conidia of the fungus and those of *F. depressum*, *C. foeniculi* and *R. foeniculi* reported by earlier workers have been compared in Table I. The authors agree

TABLE I
Comparison of the size and characters of conidiophores and conidia of the fungi causing blight diseases of *Foeniculum vulgare*

Sl. No.	Pathogen	Characters of the conidiophores	Characters of the conidia	No of septa	Authority
1	<i>Fusiciadium depressum</i>	6-7 μ \times 50-60 μ (100-120 μ on old fructifications)	6-7 μ \times 40-45 μ hyaline, irregular and constricted at middle	1	Barthelet and Vinal ²
2	<i>Cercospora foeniculi</i>	4-5-7 μ \times 10-40 μ geniculate, undulate and curved	4-6-5 μ \times 15-75 μ sub-hyaline	1-5	Chupp ³
3	<i>Ramularia foeniculi</i>	6-5 μ \times 47-55 μ fuligenous bearing conidia at extremity	6-5 μ \times 45-5 μ hyaline catenate, elongated or cylindrical	1	Sibilia ⁶
4	Fungus under study	6-4 μ \times 42-8-56-4 μ sub-hyaline, bearing conidia at the tip	6-4 μ \times 19-2-4-8 μ hyaline, catenate (2-3) cylindric	1	Authors

media with and without yeast ; sterilized stem of fennel ; Agar 1.5% + Extract of fruits and leaves of fennel 20% + water ; Agar 1.5% + Carrot decoction 15% + water and Agar 1.5% + Maltose 2% + Ammonium phosphate 0.5% + water. The fungus defied all attempts to bring it into culture on artificial media.

with Chupp³ who ruled out the possibility of the causal organism being *Fusiciadium depressum* which invariably has 1-celled, dark conidia. The fungus under study does not agree with the characters of *Didymaria* which has non-catenate conidia. It can best be accommodated in the genus *Ramularia* differing from *Cercospora* in the absence of long filiform or vermicular 3 or more celled conidia. The symptoms and general morphological characters of the pathogen, i.e., fuligenous and fasciculate conidiophores, bearing at their more or less converged extremity, 1-septate cylindrical catenate conidia with obtuse ends, compare favourably with *R. foeniculi* Sibilia, although it physiologically differs from the one studied by Sibilia⁶ in its behaviour towards growth in artificial media. Further work is in progress.

Sincere thanks are due to Shri Samrat Raj Director of Agriculture, Rajasthan, for facilities.

Plant Pathology Section, N. PRASAD.*
Department of Agriculture, R. L. MATHUR.
Rajasthan, Udaipur, J. P. AGNIHOTRI.

September 26, 1960.

1. Anonymous, *Plant Prot. Bull.*, 1950, 1, 28.
 2. **Barthelet, J and Vinal, M., *Ann. Epiphyt.* 1944, N. S., 18, Fasc. Unique, 11.
 3. Chupp, C., *A Monograph of the Fungus Genus Cercospora*, Ithaca, New York, 1953.
 4. Clements, F. C. and Shear, C. L., *The Genera of Fungi*, Hafner Publishing Co., New York, 1957.
 5. Joshi, N. C., *Agra Univ. Jour. Res.*, 1957, 6, 89.
 6. Sibilia, C., *Boll. R. Staz. Pat. Veg.*, 12, N. S., 1922, 2, 210.
 7. Sydow, H. and Mc Rae, W., *Ann. Cryptog. Exot.*, 1929, 2, 262.
- * Now Principal, S. K. N. Govt. College of Agriculture, Jodhpur.
** Original not seen.

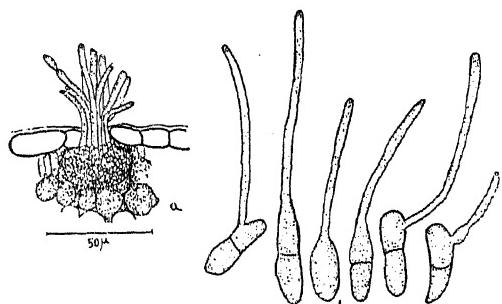


FIG 2. *R. foeniculi*. (a) Conidiophores ; (b) Germinating conidia.

The pathogenicity was tested by placing drops of sterile water containing conidia of the pathogen directly removed from the diseased stems. Typical symptoms of the disease appeared in 10-11 days on leaves, petioles, stems and pedicels of the inoculated plants only. The fungus produced was identical with the original one and possessed hyphae hyaline and intercellular ; conidiophores fasciculate arising from the stroma, sub-hyaline measuring 6-4 μ \times 42-8-56-4 μ (Fig. 2, a) ; and conidia catenulate (2-3) hyaline with mostly 1 septum, invariably cylindric, measuring 6-4 μ \times 19-2-44-8 μ .

**HEYLANDIA LATEBROSA DC.—
A PROMISING LEGUME**

IN the hilly grasslands of Raita near Bombay *Heylandia latebrosa* (Vern.—Godhadi) is a very common legume, found growing in association with tall grasses, *Themeda triandra* Forsk., *Pseudanthistiria heteroclita* Hook. f. and *Ischaemum aristatum* Linn. During the manurial studies of grasslands, it was observed by the authors that this legume established itself well and grew luxuriantly when protected from over-grazing. It checked the growth of weeds and was relished by the cattle in that area. Its flowers are sweetish and are believed to be used as pot-herb. Burns et al. (1916) had reported that this legume can form a thick carpet in grasslands. Whyte (1957) reported that yield trials of *Heylandia latebrosa* conducted over two seasons at Dharwar in Mysore State gave good response. Under the present system of harvesting at Raita, which is in the middle of October, *Heylandia* will have dried up and its proportion in the herbage is very small since the grasses whose grand period of growth lies between September and October arrest its growth by overshading it. In the middle of September, however, it is luxuriant and constitutes a substantial part of the herbage. Analysis of this legume at the flowering stage (oven-dry basis) showed: crude proteins, 0.968; ash, 6.926; insoluble ash, 0.754; Ca, 0.005; P₂O₅, 0.138; crude fats, 4.937; and crude fibres, 26.0%.

Chemical analysis of the legume at flowering stage shows that it is rich in crude protein, crude fats, and soluble ash in comparison with the grasses. Its fibre content is also less and the calcium content is good. It can, therefore, contribute to the nutritional qualities of the herbage.

Botany Department, J. V. SHANKAR.*
The Institute of Science, F. R. BHARUCHA.**
Bombay, October 28, 1960.

resent Address:

* Council of Scientific and Industrial Research, New Delhi.

** College of Agriculture, Abu Ghraib, Iraq.

.. Burns, W., Bhide, R. K., Kulkarni, L. B. and Hanmant, N. M., "Heylandia latebrosa DC.", *Bull. Lep. Agric.*, Bombay, 1916, No. 78.

.. Whyte R. O. *The Grassland and Fodder Resources of India*. The Indian Council of Agricultural Research, New Delhi, 1957, 304.

MORPHOLOGY, CYTOLOGY AND BREEDING BEHAVIOUR OF HYBRIDS BETWEEN *CORCHORUS OLITORIUS* AND *C. CAPSULARIS*

ATTEMPTS have been made without success since the early years of this century to produce hybrids between the two cultivated species of jute, *Corchorus olitorius* L. and *C. capsularis* L. with a view to combine the several desirable features which each of these species possesses.¹ Ganesan et al.² were the first to show that the failure of seed-setting in this cross is not due to lack of fertilization but is caused by the premature abortion of hybrid embryos. They also recorded the occurrence of occasional heart-shaped embryos and suggested that by culturing these embryos in suitable media, hybrid seedlings could be raised. Sulba and Swaminathan³ subsequently confirmed the findings of Ganesan et al.,² and recommended the use of reciprocal grafting, pollen irradiation and hormone application to overcome the incompatibility barrier in this cross. Encouraged by the findings of Ganesan et al.,² Islam and Rashid⁴ attempted the cross *C. olitorius* × *C. capsularis*, using 300 p.p.m. 3-indole-acetic-acid to smear the pedicel following pollination. During 1959, they found three hybrid plants among the material obtained in this way and published a brief account of the morphological characteristics and meiotic behaviour of these hybrids early in 1960.⁴

In May 1959, we observed a plant among the seedlings raised from a cross made in 1958 between *C. olitorius* var. Chinsurah green (♀) and *C. capsularis* var. JRC 13 grafted on *C. olitorius* (var. Chinsurah green) rootstock (♂), which had a weak and unbranched stem and leaves resembling closely the *capsularis* parent. This plant flowered earlier than the female parent but later than male and produced a few, mostly solitary, flowers. The capsules were strikingly intermediate in shape and size, with irregular projections and depressions running along the ribs (Fig. 1). These features suggested that this plant may be a real hybrid between *olitorius* and *capsularis*.

Meiosis was studied in the microsporocytes of this plant and in 7 out of the 15 cells examined at Metaphase I, one quadrivalent or one trivalent and a univalent were present (Fig. 2). Six bivalents and two univalents were seen in 5 cells. The mean frequency per cell of the different types of associations was: 0.2_{IV} + 0.27_{III} + 5.47_{II} + 1.47_I. Pollen fertility as estimated by stainability in acetocarmine was 60%. The average number of seeds per capsule

was 74.8 in the F_1 in contrast to 204.3 and 41.7 found in *C. olitorius* and *C. capsularis* respectively. The colour of the seed-coat was steel-gray in the hybrid as compared to green in the female parent and brown in the male parent. The seeds were also intermediate in size.

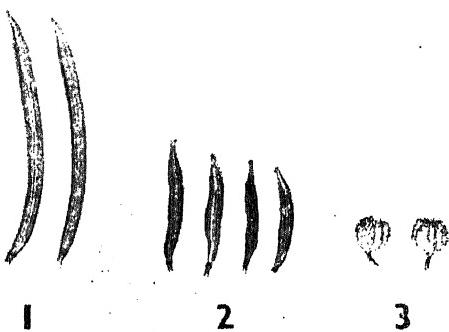


FIG. 1. Capsules of (1) *Corchorus olitorius*, (2) F_1 hybrid and (3) *C. capsularis*.



FIG. 2. Metaphase I in the F_1 plant showing $4_{II} + 1_{IV} + 2_I$ (one univalent is lying over a bivalent).

A study of the progeny of this plant raised during 1960 confirmed the hybrid nature of the parent. Thus, there was segregation in the F_2 population for (a) growth and vigour, (b) branching habit, (c) leaf length/breadth index and serration, (d) date of first flowering, (e) flower characters and (f) capsule size and shape. Also, the percentage of survival in the F_2 progeny was only 60 in contrast to the nearly complete survival found in the case of the two parents. While the detailed data will be reported elsewhere, it may be mentioned here that the germination, survival and segregation behaviour of the F_2 population conforms to the pattern reported in interspecific crosses in genera where cryptic structural differentiation of chromosomes has played an important part in speciation.⁵

During 1960, one more hybrid plant was obtained from a cross between *C. olitorius* var. IC 325 grafted on *C. capsularis* var. JRC 212 rootstock and *C. capsularis* var. IC 330 (pollen irradiated with 2,000 r of X-rays). This hybrid resembled closely the one isolated during 1959 and was also characterised by the presence of one quadrivalent in the microsporocytes. Thus, though different varieties of *olitorius* and *capsularis* had been involved in the parentage of these two hybrids, both showed heterozygosity for a reciprocal translocation. Islam and Rashid⁴ have, however, recorded regular bivalent formation in the hybrid plants studied by them. The interchange observed in our 1960 hybrid could also have been induced by the radiation treatment, though pollen transmission of such aberrations is rare. Thus, the reciprocal translocation recorded in our material may not *per se* be a species differentiating factor. From the occurrence of unthrifty seedlings and block transference of certain parental characters in the F_2 population, cryptic structural differentiation appears to have been an important mechanism controlling the divergence of these two cultivated species. Only further studies would show whether this would impose any limitation on the breeding possibilities of this material. The successful hybridization of these two species, after several decades of unsuccessful attempts, is, however, a significant achievement and may well prove to be an important milestone in the history of jute breeding in India.

We are indebted to Dr. B. P. Pal, Director, and Dr. A. B. Joshi, Head of the Division of Botany, for their advice and encouragement. We are also grateful to Dr. S. M. Sikka, Additional Agricultural Commissioner with the Government of India, for his interest in this study. Finally, our sincere thanks are due to Messrs. N. Gupta, H. C. Bansal and R. P. Puri for assistance in crossing work.

Indian Agri. Res. Inst., M. S. SWAMINATHAN.
New Delhi, R. D. IYER.
October 22, 1960. K. SULBHA.

1. Kundu, B. C., *Jute in India*, Published by the Indian Central Jute Committee, Section I. Agriculture, 1959, p. 41.
2. Ganesan, A. T., Shah, S. S. and Swaminathan, M. S., *Curr. Sci.*, 1957, 26, 292.
3. Sulbha, K. and Swaminathan, M. S., *Ibid.*, 1959, 28, 460.
4. Islam, A. S. and Rashid, A., *Nature*, 1960, 185, 258.
5. Stebbins, G. L., *Variation and Evolution in Plants*, Columbia University Press, 1950, p. 643.

EPI COCCUM NIGRUM LINK.: A NEW REPORT FROM INDIAN SOILS

Epicoccum is a genus of Moniliales belonging to the family Tuberculariaceæ, reported as occurring in the soils of Canada.¹ Recently Ragab² has reported the genus from soils of Egypt. During the course of the study of the fungal flora of 'Usar' soils of Uttar Pradesh (R. N. Ghosh, unpublished), *Epicoccum nigrum* has been isolated from soil samples collected at Banthra Extension Nursery of the National Botanic Gardens, Lucknow. The fungus is isolated from soil samples collected during the rainy season (July to October) of 1959 at a depth of 6-18" from the surface. The soil is typically 'Usar' with an average pH range of 1.24 to 9.89 and an average moisture content

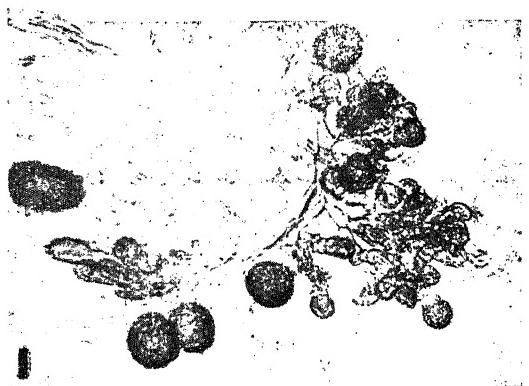


FIG. 1. Photomicrograph of *Epicoccum nigrum* Link. showing conidia and conidiophores.

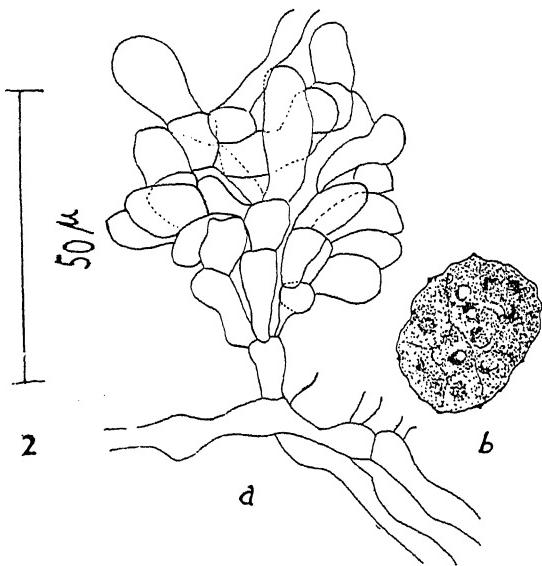


FIG. 2. (a) Conidiophores. (b) Single Conidium.

of 2.35 to 6.99. Soil cultures were made by Waksman soil dilution plate method,³ and maintained on synthetic nutrient agar slants. Sporodochia were produced in cultures maintained at room temperature in 4 to 6 days.

The stroma is black and the reverse of the colony is bluish-black in colour. The sporodochia are scattered and hemispherical. Conidiophores are club-shaped (Fig. 1), and black in colour. The size of the conidiophores ranges from 12.3×5.0 to $14.0 \times 7.0 \mu$. The conidia are spherical, 21 to 25 μ occurring singly at the tip of the conidiophores, and brown to black in colour. The surface of the conidia possesses minute granulation (Fig. 2).

Epicoccum nigrum Link. has been isolated for the first time from Indian soils.

Thanks are due to Prof. K. N. Kaul, Director, for the help and encouragement during the study. Thanks are also due to the Head of Mycology and Plant Pathology Division, I.A.R.I., New Delhi, for the confirmation of the identification.

Fungi Section,
Botany Laboratory,
National Botanic Gardens,
Lucknow, October 5, 1960.

R. N. GHOSH.

1. Bisby, G. R., Timonin, M. and James, N., *Canad. Jour. Res.* (Sec. C), 1935, 13, 47.
2. Ragab, M. A., *Mycologia*, 1956, 48, 167.
3. Waksman, S. A., *Principles of Soil Microbiology*, William & Wilkins Co., Baltimore, U.S.A., 1927.

MULTIPARASITISM BY AHOLCUS EUPROCTISCIDIS MANI AND TRICHOGRAMMA EVANESCENS MINUTUM RILEY IN THE EGGS OF EUPROCTIS LUNATA WALKER

Euproctis lunata Walker is a very serious pest of castor in the plains of India. Two species of parasites were observed to breed in the eggs of this pest. One was the scelionid, *Aholcus euproctiscidis* Mani, and the other the trichogrammatid, *Trichogramma evanescens minutum* Riley. Careful observations by the dissection of the eggs of *Euproctis* revealed the occurrence of multiparasitism. Very often multiparasitism results in the death of one or the other species and in the present case it was observed that invariably *Trichogramma* successfully completed development and emerged.

Experiment No. 3.—When these host eggs were dissected 5 hours after exposure to *Trichogramma*, dead first instar larvae of *Aholcus* and *Trichogramma* eggs were observed.

Identical results were obtained when the host eggs were dissected one hour after exposure to *Trichogramma*.

EXPERIMENTS AND OBSERVATIONS

TABLE I

Experiment No.	Condition of host eggs when exposed	Host eggs exposed to	Whether the parasite accepted them or not	Whether development of <i>Aholcus</i> takes place or not	Whether development of <i>Trichogramma</i> takes place or not
1	Just parasitised by <i>Trichogramma</i>	<i>Aholcus</i>	Yes	No	Yes
2	Just parasitised by <i>Aholcus</i>	<i>Trichogramma</i>	Yes	No	Yes
3	With 24-hour old larva of <i>Aholcus</i>	do.	Yes	No	Yes
4	With 30-hour old larva of <i>Aholcus</i>	do.	Yes	No	Yes

Experiment No. 4.—When host eggs containing 30-hour old larvae of *Aholcus* were dissected 5 minutes after exposure to *Trichogramma*, live first instar larvae of *Aholcus* and *Trichogramma* eggs were observed. Dissection 10 minutes after *Trichogramma* laid eggs, showed that the first instar larvae of *Aholcus* were rather sluggish. Body movements were not noticed. Only the mandibles showed slight movement. In other words, they were in a moribund stage. All host eggs in which *Trichogramma* eggs were allowed to develop for more than 10 minutes showed only dead first instar larvae of *Aholcus*.

It was further observed that when the host eggs were first attacked by *Trichogramma* and then by *Aholcus*, the number of *Trichogramma* emerged (from a single host egg) was more and the development was completed in a shorter period than when the host eggs were first attacked by *Aholcus* and then by *Trichogramma* (see Tables II and III).

TABLE II
Host eggs parasitised first by *Trichogramma* and then by *Aholcus*

Serial No. of host eggs	No. of <i>Trichogramma</i> emerged	No. of <i>Aholcus</i> emerged	No. of days taken for development and emergence at 75-80° F. and relative humidity 75%
1	5	0	
2	6	0	
3	5	0	
4	5	0	
5	5	0	
6	6	0	11 days

TABLE III
Host eggs parasitised first by *Aholcus* and then by *Trichogramma*

Serial No. of host eggs	No. of <i>Trichogramma</i> emerged	No. of <i>Aholcus</i> emerged	No. of days taken for development and emergence at 75-80° F. and relative humidity 75%
1	2	0	
2	2	0	
3	2	0	
4	2	0	
5	2	0	
6	3	0	

It is rather interesting to note that the very presence of *Trichogramma* eggs is detrimental to the grubs of *Aholcus*.

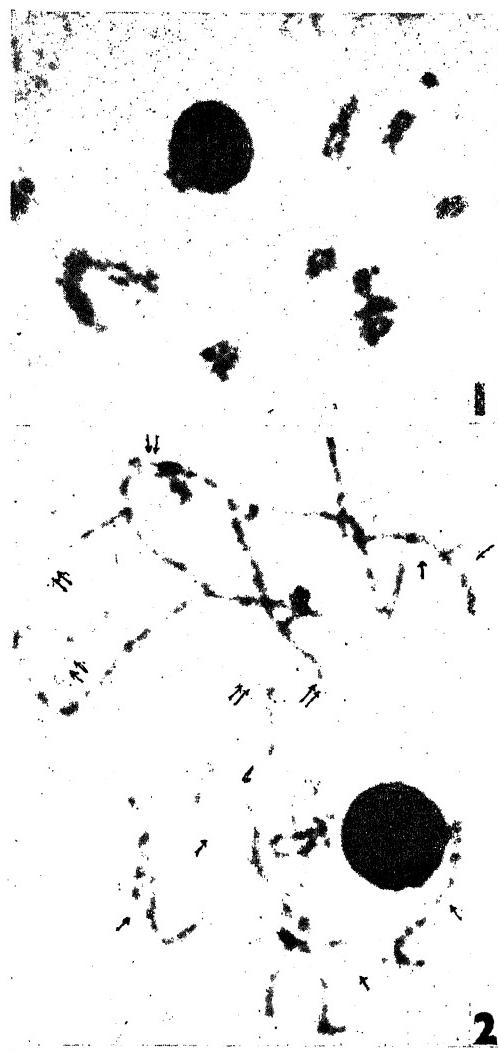
Division of Entomology, B. R. SUBBA RAO,
Indian Agri. Res. Inst., M. J. CHACKO.
New Delhi-12, October 17, 1960.

PACHYTENE ANALYSIS IN JAPONICA-INDICA RICE HYBRIDS

CYTOTOLOGICAL analyses of inter-sub-specific hybrids of *Oryza sativa* L. were undertaken by several workers,^{3,4,6,8} all of whom emphasized the existence of chromosome structural hybridity. Oka⁵ and his collaborators,² on the other hand, postulated that the sterility in these hybrids is due to the recombination between several pairs of duplicate genes. Since all the earlier investigators except one⁸ confined their analysis to diakinesis and later stages of meiosis, the present study was undertaken to analyze these hybrids at diplotene and pachytene stages.

The most significant observation in the present study was of the occurrence of small translocations which were recorded as quadrivalents at diplotene (Fig. 1) in 1.5 to 10.3% of the cells. Their infrequent occurrence is probably due to the smallness of the interchanges and their sub-terminal location. Unlike in the inversion heterozygotes, where the occurrence of an anaphase bridge is a prerequisite for the reduction in fertility, the translocation heterozygotes might be of reduced fertility by the independent assortment of the chromosomes whether the quadrivalents are recorded or not. It is possible to reinterpret Oka's G. D. genes as small translocations where the homologous segments are located on non-homologous chromosomes. The reduction in fertility is expected to be 25% by either of the hypotheses. Similar view was expressed by Stebbins (cited

by Oka⁵), but was not adopted by Oka for lack of positive cytological evidence in favour of translocations.



FIGS. 1-2. Fig. 1. F_1 hybrid, T. 21, \times A-18. Diploid $1_{IV} + 10_{II}$. Fig. 2 F_1 hybrid, T. 21, \times A-18. Pachytene. Several differential segments (\nearrow) and heteromorphic terminal ends ($\nearrow\swarrow$).

In one of the three hybrids studied, 31% of the total chromatin length was unpaired at pachytene, the unpaired regions being expressed as differential segments (Fig. 2). It is considered that these segments represent cases of small translocations, in view of a relatively minor role of inversions in the differentiation of these parents and by the high sterility recorded in these hybrids. The present authors propose the term "differential index" to

designate the percentage of the chromatin which is unpaired at pachytene with the hope that it might serve as a useful cytological measure of structural hybridity and thereby permit the prediction of sterility in these hybrids. In the hybrids studied, with an increase in differential index, the sterility exhibited a corresponding increase.

Differential segments unravelled in the present study not only account for sterility, but also the accompanying genetic effects, viz., non-recovery of recombinant phenotypes and the occurrence of various types of abnormal plants which have been interpreted by earlier workers⁶ as due to high genetic instability of these hybrids. When bivalents are paired only for a part of their length at early prophase and the unpaired regions represent several interchanges which have attained a balance for viability in the parental combinations, crossing over in the paired segments leads to the production of duplication-deficiencies in the gametes, accompanied by a depression in recombination index. If some of the deletions are viable, the occurrence of the so-called mutations⁷ and of *albinas* (Shastry, unpublished) can be adequately explained.

It is concluded from the present study that causes for sterility in *Japonica-indica* rice hybrids are more due to chromosome structural hybridity than to the operation of complementary factors.

We express our gratefulness to Dr. B. P. Pal, Director, and Dr. A. B. Joshi, Head of the Division of Botany, for their interest in the study, and to Dr. M. S. Swaminathan for valuable suggestions.

Division of Botany, S. V. S. SHAstry,
Indian Agri. Res. Institute, R. N. MISRA.
New Delhi-12, October 20, 1960.

1. Henderson, M. T., Yeh, B. P. and Exner, B., *Cytologia*, 1959, 24, 415.
2. Heieh, S. and Oka, H., *Jap. J. Genet.*, 1958, 33, 73.
3. Kuang, H. H., *Agron. Jour.*, 1951, 43, 387.
4. Mello Sampayo, T., *Genetica Iberica*, 1952, 4, 43.
5. Oka, H., *J. Genet.*, 1957, 55, 397.
6. Sampath, S. and Mohanty, H. K., *Curr. Sci.*, 1954, 23, 182.
7. Venkateswamy, T., *Associateship Thesis*, Indian Agricultural Research Institute, 1957.
8. Yao, Y., Henderson, M. T. and Jodon, N. E., *Cytologia*, 1958, 23, 46.

AMITOSIS IN THE ENDOSPERM OF *ZEPHYRANTHES AJAX* SPRINGER

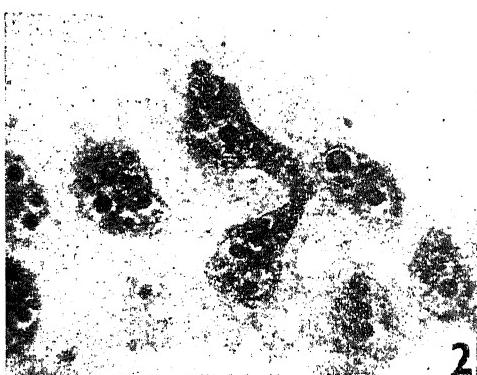
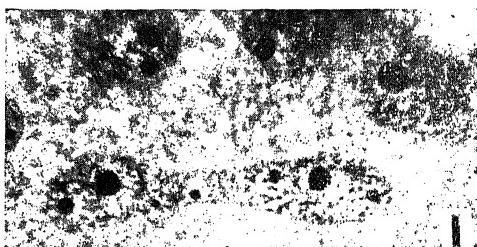
THE term amitosis is applied to nuclear division in which nucleus simply constricts and separates into two or more portions. It was at one time looked upon as the prevailing mode of nuclear division.⁴ While this may still be true for the lower forms, it is now known that amitosis occurs in exceptionally rare cases in higher organisms. The amitotic figures have been frequently reported in cells with a nutritive function, such as tapetal, antipodal and endosperm cells of angiosperms. Johansen recorded amitosis in the endosperm of *Zauschneria latifolia*² and *Anogra pallida*.³ Recently, Wang and Chien⁵ have reported the occurrence of three different types of amitoses in the cotton endosperm. While studying the cytology of the endosperm of *Zephyranthes ajax* we came across a number of amitotic figures. The details and significance of these are reported in the present paper.

The fertilized ovules of different ages were fixed in acetic alcohol (1:3). These were then dissected under a binocular and the endosperm thus taken out was stained with iron-aceto-carmine. The endosperm tissue was not subjected to any pressure. Even the slightest tapping of the cover-slip was avoided.

Amitosis in *Zephyranthes ajax* was seen to commence with the elongation of the nucleus (Fig. 1). The nucleus at this stage showed slight narrowing in its middle region. The narrowing gradually increased and the constriction became more and more pronounced (Figs. 2 and 3). In very advanced stages the lobes of the nuclei were connected by means of thin chromatin threads. Finally the nuclei broke into two or more parts (Fig. 4). It was observed that when a nucleolus happened to be included in the constricted region, it also underwent similar changes as the nucleus. The amitotic figures appeared more frequently in the free nuclear 4-day-old endosperm than at any other stage of its development. The frequency of the occurrence of amitotic figures decreased with the advancement in the age of the endosperm. In general, nuclear abnormalities including amitosis are of more frequent occurrence in hybrids than in homozygous species. The present findings are in conformity with this as the plant investigated is of hybrid constitution.¹

The endosperm of *Zephyranthes ajax* in its earlier stages of development showed a significant variation in the size and shape of its nuclei. These nuclei of different sizes and

shapes could have arisen as a result of the sequence of changes in amitosis described



FIGS. 1-4. Stages of amitosis in *Zephyranthes ajax*. earlier. One of the possible causes for the variation in the size and shape of nuclei in the

endosperm of *Zephyranthes ajax* may thus be the occurrence of amitosis. It may be stated here that opinions on the question as to whether or not a portion of a nucleus resulting from amitosis can subsequently divide by mitosis are conflicting.

The results reported in this note form part of the work which is being carried out in a research scheme sanctioned by Council of Scientific and Industrial Research, New Delhi. The authors gratefully acknowledge the financial assistance of the Council.

Department of Botany,
University of Delhi,
Delhi-6, October 10, 1960.

S. L. TANDON.

B. M. KAPOOR.

1. Bailey, L. H., *Manual of Cultivated Plants*, Macmillan & Co., New York, 1949.
- *2. Johannsen, D. A., *Ann. N.Y. Acad. Sci.*, 1931, **33**, 1.
3. —, *Amer. J. Bot.*, 1931, **18**, 854.
4. Sharp, L. W., *Introduction to Cytology*, McGraw-Hill Book Company, New York, 1934.
5. Wang, F. H. and Chien, N. F., *Acta Botanica Sinica*, 1957, **6**, 29.

* Original not seen.

CHROMOSOME NUMBER OF SOME FLOWERING PLANTS

A PERUSAL of literature reveals that the chromosome numbers of the undermentioned plants still remain unexplored. The somatic counts were made from root-tip squashes stained in aceto-orcein followed by pre-treatment with several chemicals, such as, æsculinine, coumarin, para-dichloro-benzene and oxyquinoline which gave good results. The gametic counts were determined from PMC smears using aceto or propino-carmine. To the best of the knowledge of the author, the chromosome numbers reported in Table I are new records.

TABLE I

No.	Name of plants	Family	Chromosome number	
			n	2n
1.	<i>Eupatorium odoratum</i> L.	Compositæ	..	58
2.	<i>Walsura piscidia</i> Roxb.	Meliaceæ	14	28
3.	<i>Bursera serrata</i> Wall. =(<i>Prectium serratum</i>) (Wall. ex Coleber) Engl.	Burseraceæ	11	22
4.	<i>Garuga pinnata</i> Roxb.	do	13	26

The above species whose chromosome numbers have been determined are all of economic importance. *Eupatorium odoratum* grows as weed plant in Bengal. This plant is propagated vegetatively and shows variability

in chromosome number of somatic cells, such as $2n = 54, 56$, etc. The oil extracted from the leaves of *E. odoratum* may have insect repellent properties.¹ *Walsura piscidia* does not grow wild being mainly cultivated in gardens for its medicinal value. The members of the Meliaceæ often show polyploidy but the genus *Walsura* (Meliaceæ) seems to represent the true diploid nature. The whole of the Burseraceæ lacks cytological information. The only plant of this family whose chromosome number, as revealed from Darlington and Wylie, *Chromosome Atlas of Flowering Plants*, has been determined is that of *Commiphora berryi* ($n = 13$; $2n = 26$).² The present author adds some knowledge by presenting the chromosome numbers of two other members of the Burseraceæ, such as, *Bursera* and *Garuga*. *Bursera serrata* and *Garuga pinnata* are not found to grow as wild plants but are often cultivated in gardens for their medicinal purposes. In these two species, the presence of 'ploidy' and 'secondary association' has also been noted by the present author.

The detailed cytological and embryological studies of these species will be published elsewhere.

My cordial thanks are due to Dr. I. Banerji, for constant encouragement and helpful suggestions and to Dr. S. M. Sircar, for giving necessary facility for this work. My thanks are also due to the Ministry of Education, Government of India, for awarding a Research-Training Scholarship.

Dept. of Botany, RASH BEHARI GHOSH.
Calcutta University,
Calcutta, November 1, 1960.

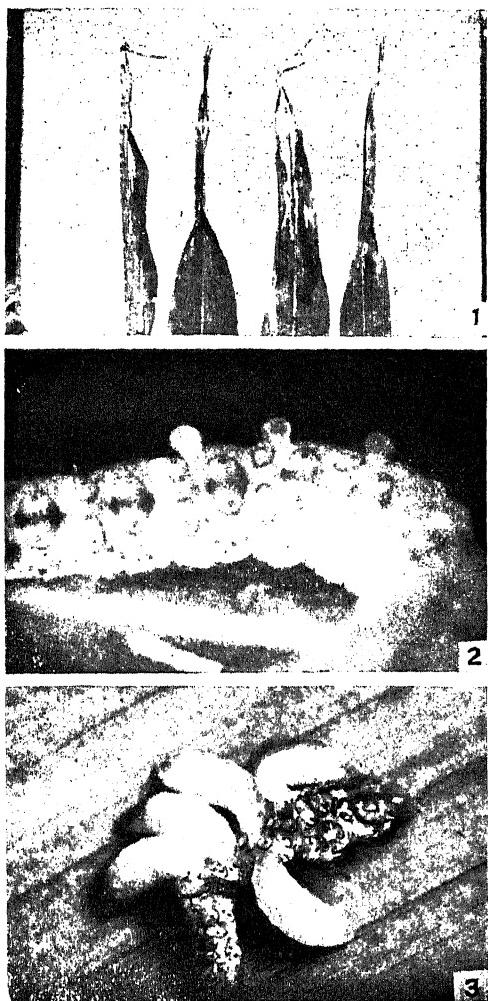
1. Krishnaswamy, N. and Raman, V. S., *Curr. Sci.*, 1949, **18**, 376.
2. Mohni, N. S. and Subramaniam, R. *Indian Forester*, 1960, **86**, 209.

THE NATURAL ENEMIES OF *MARASMIA TRAPEZALIS* (GUEN.), A PEST OF MAIZE AND JOWAR

THE leaf roller, *Marasmia trapezalis* (Guen.), is recorded as a minor pest of millets in South India (Fletcher¹; Ayyar²). This insect hitherto considered as a pest of minor importance in Northern India, made its appearance in some numbers on young maize and jowar plants at I.A.R.I., in 1958. Since then, the pest has been on the increase and recently there was an outbreak of the insect on jowar and maize crops in and around Delhi.

M. trapezalis caterpillar rolls up leaf tips and fastens the edges with silk and remains hidden in

the rolled leaf. It scrapes the epidermis of leaves and feeds on the green tissue. Leaves damaged by the caterpillar show longitudinal patches and dried leaf tips (Fig. 1). The caterpillar



FIGS. 1-3. Fig. 1. Jowar leaves showing rolled leaves and *Marasmia* damage (reduced). Fig. 2. Early instar grubs of *Goniozus* feeding on host caterpillar (highly enlarged). Fig. 3. Fully grown grubs of *Goniozus* and the host caterpillar (enlarged).

is yellowish green, slender, and becomes very active when disturbed. At I.A.R.I. experimental fields about 40% of the jowar plants were affected, and some of the exotic varieties with broad leaves, had the maximum attack.

An investigation of the cause of the increased infestation of *M. trapezalis* with special reference to biotic factors, was recently taken up by the authors. Preliminary studies have revealed the presence of at least two parasites and a microbial disease, which under favourable conditions,

are capable of keeping the pest in check. The present note deals with one of them, a bethylid (*Goniozus marasmi* Kurian) which attacks the larva of *M. trapezalis*.

Goniozus seems to prefer medium-sized larva for parasitisation. In the laboratory, full grown caterpillars are generally avoided, while younger stages are readily accepted. The female parasite remains in the leaf roll, waiting for the host caterpillar, and rarely takes to flight. When the host is located, the parasite suddenly seizes it by its curved mandibles and keeps the caterpillar pressed down. As soon as the caterpillar becomes quiet, the parasite bends its body around the caterpillar and stabs it in between the first pair of thoracic legs. Apparently a neurotoxin is injected into the main nerve ganglions which brings about an immediate, but temporary paralysis, lasting for nearly 30-40 minutes. Soon after paralysing the host, the parasite drags it to a suitable place and commences oviposition. The female first walks over the host and examines it with its mandibles and ovipositor. If a parasitised host is offered to the female parasite, it invariably feeds on the eggs and young grubs already present. The habit of feeding on the host body fluids that exude from wounds on hosts is commonly met with in many parasitic hymenoptera, but this peculiar habit of preying on its own species seems to be rather interesting. After cleaning the host of the parasite grubs and eggs already present, it starts probing the host body with its ovipositor for a suitable site to fix the egg. When a suitable place is located, which is generally on the dorso-lateral region in between the two lateral setae, the tip of the ovipositor is pressed against the host body and the egg starts descending down. The eggs are glued firmly to the host cuticle in a transverse position. After laying an egg it shifts the abdomen to the opposite side and then lays another on the opposite side. Then it moves forward and lays two more eggs in the next abdominal segment. In this way, a parasite laid 6 eggs at one sitting in the laboratory, in the course of about 40 minutes. The parasitised caterpillar recovers from the sting in about half an hour and continues to move and feed.

The eggs of *Goniozus* are elongate, glistening white, and not easily detected on the host. The egg period is quite short and the grub on hatching remains anchored to the host at the same spot and feeds on the host body fluids (Fig. 2). Even after the parasite grubs have grown to some size the host is capable of slight movement. The grub completes its development in about 2 days at the expense of the host

caterpillar which is devoid of its body contents, resulting in death (Fig. 3). The pupal period under laboratory conditions varied from 5-6 days.

The preliminary observations have shown that the parasite has many qualities which indicate its efficiency as an agent of control. It has a very short life-cycle as compared to that of the host, the adult life is long, and it possesses the ability to search for, find and successfully attack the host even when the host population is low. The increased infestation of *M. trapezalis* on jowar may be partially attributed to the adverse effects of modern insecticides which have come to be generally recognised and accepted since the advent of powerful organic insecticides. The use of insecticides on crops can be better integrated with biological control by changes, deletions, modifications of timing, dosage, or method of application.

Our sincere thanks are due to Dr. B. P. Pal, Director, Dr. E. S. Narayanan, Head of the Division of Entomology, for the facilities, and to Prof. S. Pradhan, for his keen interest in the problem. Thanks are also due to Dr. K. O. Rachie, Sorghum Specialist, Rockefeller Foundation, for the facilities extended for work on insect problems in jowar.

I.A.R.I., Division of Entomology, New Delhi,

September 24, 1960.

1. Fletcher, T. B., *Some South Indian Insects.*, 1914, pp 432-33.
2. Ayyar, T. V. R., *Handbook of Economic Entomology for South India*, 1940, pp. 180.

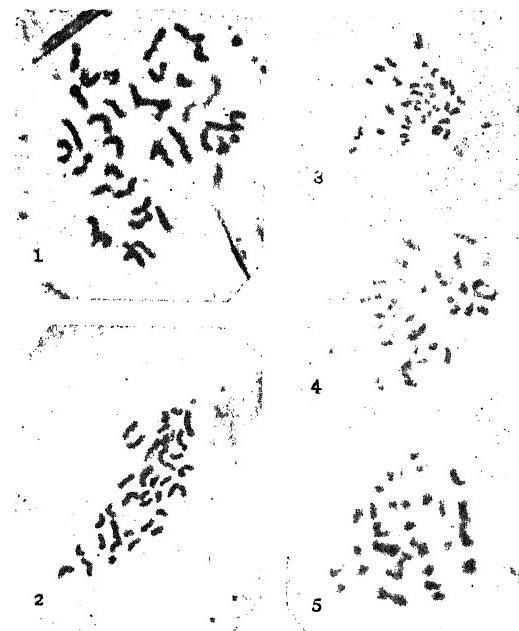
THE CHROMOSOME NUMBERS OF A FEW MORE ORCHID GENERA

In a previous communication (Sharma and Chatterji, 1960), chromosome numbers of nine different species of Orchids were reported, noted in connection with the detailed cytological work undertaken, in this laboratory. In the present report, chromosome numbers of five more species are being reported. Of these, *Cymbidium lowianum*, *C. munronianum*, and *Renanthera imschootiana* belong to the tribe Vandææ, whereas *Arundina bambusæfolia* and *Cœlogyné corymbosa* fall under the tribe Epidendreæ. The chromosome numbers are:—

1. *Cymbidium lowianum* Rchb.f. ... $2n=40$ (Fig. 1)
2. *C. munronianum* King and Pantl. $2n=40$ (,, 2)
3. *Renanthera imschootiana* Rolfe $2n=38$ (,, 3)
4. *Arundina bambusæfolia* (Roxb.) Lindl. $2n=40$ (,, 4)
5. *Cœlogyné corymbosa* Lindl. ... $2n=38$ (,, 5)

It may be noted that both $n=19$ and 20 chromosomes have been found in other species of Vandææ as well (Storey, 1953; Miduno, 1938, 1940, 1954, etc.). It appears that the genus

Cymbidium is quite a homogeneous one in which all the species so far reported contain $n=20$ chromosomes (Wimber, 1957). With



FIGS. 1-5. Fig. 1. Somatic metaphase of *Cymbidium lowianum* showing 40 chromosomes ($\times 2,000$). Fig. 2. Somatic metaphase of *C. munronianum* showing 40 chromosomes ($\times 1,400$). Fig. 3. Somatic metaphase of *Renanthera imschootiana* showing 38 chromosomes ($\times 1,200$). Fig. 4. Somatic metaphase of *Arundina bambusæfolia* showing 40 chromosomes ($\times 2,100$). Fig. 5. Somatic metaphase of *Cœlogyné corymbosa* showing 38 chromosomes ($\times 2,100$).

regard to the genus *Cœlogyné*, all the three species explored by previous workers (Hoffmann, 1930) contain $2n=40$ chromosomes, whereas in the present investigation 38 chromosomes have been found. It appears, therefore, that as in *Orchis* (Vermuelen, 1947; Hagerup, 1938), in this genus too, aneuploidy is prevalent.

Cytogenetics Laboratory, A. K. SHARMA.
Dept. of Botany, A. K. CHATTERJI.
Calcutta University,
Calcutta-19, September 1960.

1. Hagerup, O., *Hereditas*, 1938, 24, 258.
2. —, *K. dansk. vidensk. Selsk. Biol. Medd.*, 1939, 20 (9), 1.
3. Hoffmann, K. M., *Planta*, 1930, 10, 523.
4. Miduno, T., *Cytologia*, 1938, 8, 505.
5. —, *Ibid.*, 1940, 11, 179.
6. —, *Ibid.*, 1954, 19, 239.
7. Sharma, A. K. and Chatterji, A. K., *Proc. Ind. Sci. Cong. 47th Session (Bot. Sec.)*, 1960.
8. Storey, W. B., *Bull. Pacif. Orchid Soc.*, Hawaii, 1953, 11, 17.
9. Vermuelen, P., *Studies on Dactylorhizids*, Utrecht, 1947.
10. Wimber, D. E., *Amer. Orchid Soc. Bull.*, 1957, 26 (9), 636.

REVIEWS

Introduction to Quantum Field Theory. By F. Mandl. (Interscience Publishers Inc., New York), 1959. Pp. vi + 202. Price \$ 16.00.

During the past few years a number of books have appeared on the quantum theory of fields, but practically all are written in such an abstract and condensed style that they are either uninteresting or unintelligible to the majority of physicists. A book that explains the principles of the field theory in a language that is mathematically not difficult will therefore find reception amongst all physicists, theoretical or experimental, and the book by F. Mandl is to be welcomed for this reason.

In about hundred and sixty pages which are distributed in twenty-two chapters, the author explains the basic ideas of field quantisation which would enable the reader to gain mastery over the modern perturbation-theoretic methods of quantum field theory. The author has developed the subject on the basis of the ideas of Dyson and Feynman, which enable one to interpret mathematical expansions corresponding to decay or interaction processes between elementary particles in terms of simple graphs. The first eight chapters of the book deal with quantisation of fields and in these the author derives the commutation rules for different types of fields, e.g., boson, meson, and fermion fields. Chapters nine and ten deal with photons and the quantisation of electromagnetic fields. Since the coupling constant between the electromagnetic and electron fields is weak, the perturbation theoretic procedure is quite rigorous for this interaction, and consequently relativistic quantum field theory has its most striking successes in quantum electrodynamics. In these chapters, the author gives the commutation relations satisfied by the components of the electromagnetic field and further develops the Gupta-Bleuler formalism here. Chapters twelve and thirteen deal with the scattering matrix or the so-called S-matrix and final chapters of the book treat topics such as Compton scattering, Feynman diagrams, Radiative corrections, Vacuum polarisation and Renormalisation theory.

The book is supplemented by a number of exercises which would help the student to gain a mastery of the principles and techniques of the subject. The book is warmly recommended to all students of the quantum theory of fields.

Principles of Modern Physics. By Robert B. Leighton. (Published by McGraw-Hill Book Co., Inc., New York), 1959. Pp. 795. Price \$ 12.50.

This book by Prof. Leighton is a carefully thought-out and well-planned book on modern physics. It covers a broad range of subjects and at the same time would take the student sufficiently deep into the various aspects of modern physics. The treatment is fairly advanced and assumes on the part of the students using the book not only a good preliminary knowledge of the fundamental facts of modern Physics such as atomic theory and atomic spectrum, heat radiation, kinetic theory and radioactivity, but also a good background knowledge of different branches of mathematics. A third of the book is devoted to nuclear physics. It includes such recent advances in physics as the band theory of solids, non-conservation of parity, strange particles, Fermi mechanism of cosmic ray acceleration, nuclear shell structure, formation of elements in stars, etc.

If a student really wants to understand modern physics and not merely "learn" it for an examination, then this is the book for him. The numerous examples interspersed as part of the text will try his ingenuity and clear thinking before he could proceed further. The book is recommended not only for the final year University students in physics but also to those who are engaged in physical research. A. S. G.

Proceedings of the Cosmic Ray Symposium, 1960. (The Cosmic Ray Research Committee of the Department of Atomic Energy, Government of India, in Conjunction with Physical Research Laboratory, Ahmedabad), 1960. Pp. xii + 446. Price not given.

The Cosmic Ray Research Committee of the Department of Atomic Energy, Government of India, organises every year a symposium on Cosmic Rays. The sixth symposium was held at Ahmedabad on March 18-19, 1960. A welcome practice was adopted last year to bring out the proceedings of the symposium in a collected form so as to make them easily available not only to the participants but also to all workers, laboratories and institutions interested in this important field of research.

The present volume of the *Proceedings* begins with the contents of the lecture "Origins of

"Cosmic Rays" delivered by Prof. P. Morrison of the Cornell University, U.S.A., when he inaugurated the Symposium. Prof. Morrison has indicated a fruitful approach to the study of the origins of cosmic rays, namely, to regard them as a natural part of the evolution of stars and of galaxies. The volume contains 62 papers which were presented and discussed at the symposium in which about an equal number of workers from different parts of India participated. The papers cover nearly all aspects of cosmic ray research, such as origin of cosmic rays, their time variations, solar and terrestrial relationships, geomagnetic activity, extensive air-showers, high-energy nuclear interactions, radio-isotopes produced by cosmic rays and their geophysical applications, instrumentations in cosmic ray studies, etc.

The editors deserve congratulations in having brought out the *Proceedings* in less than six months of the symposium. This has been made possible by having recourse to cyclostyled printing. The *Proceedings* will be useful to all research workers in cosmic ray physics as they contain latest results and developments in this field. The discussions at the end of each paper and the references to current literature, add to the value of the book.

A. S. G.

Jets and Rockets. By A. Barker, T. R. F. Nonweiler and R. Smelt. (Chapman & Hall Ltd., London), 1959. Pp. 268. Price 35 sh.

The object of the book is to provide an introductory text-book on all forms of jet propulsion, rocket, turbojet, pulse jet, etc., and on the whole it achieves this purpose well. The main features of each power plant are described clearly and the calculations of thrust coefficients and fuel consumption are given. Emphasis is made on high speed aerodynamics of jet propulsion. The book concludes with a chapter on future developments, appendices of useful data, and a bibliography. Though somewhat out of date, the book contains much useful information which beginners in the subject will appreciate.

A. S. G.

A Guide-Book to Biochemistry. By Kenneth Harrison. (Cambridge University Press, London N.W. 1), 1959. Pp. 150. Price: Cloth Edition 17 sh. 6 d.; Paper Edition 10 sh. 6 d.

Although there are several good text-books on this rapidly growing subject of biochemistry, they are either too long or too specialised. For

the beginner in the subject or for those working in other allied disciplines who would like to keep themselves abreast in this field of study by attempting to follow the continuous flow of papers that are being published, there is a need for an introductory book on biochemistry. This little book of about 150 pages excellently serves this purpose.

After a short introductory chapter, describing the chief branches of research in biochemistry, the subject is developed in a logical way dealing with catalysis by enzymes and energy production through oxidative mechanisms. There is a chapter on photosynthesis which is followed by three chapters respectively on carbohydrate metabolism, fat metabolism and protein metabolism. The last chapter deals with control of metabolism.

The paper cover edition at cheaper price will be welcomed by many.

A. S. G.

New Books in Applied Mathematics and Mathematical Physics. (Dover Publications, Inc., 180, Varick Street, New York-14, N.Y.)

Dover Publications, whose inexpensive editions of basic scientific texts are well known to students and workers in technical fields, has recently republished the following five books in their series of texts in advanced mathematics and mathematical physics.

Statistics Manual (pp. 288, Price \$ 1.55) written by Dr. Edwin L. Crow in collaboration with Frances A. Davis and Dr. Margaret W. Maxfield. This is a comprehensive collection of classical and modern methods of making statistical inferences, designed for all those who work in fields using statistics. It contains amongst other topics, determination of sample size, relations of means and variances, chi-square runs, quality control, acceptance sampling, etc. The many examples taken from ordnance development will prove useful to workers in all fields. A special feature of the book is the appendix of 21 tables and 11 charts, some of which are difficult to find elsewhere.

Algebras and Their Arithmetics by Leonard Eugene Dickson (pp. 241, price \$ 1.35). This provides the background necessary to a complete understanding of the general theory of algebra. The author begins with an elementary introduction to linear transformations, matrices, and the field of complex numbers. This is followed by a discussion of order, basal units, modulus and quaternions. Then follow chapters which describe various examples of algebras, including invariant difference, nilpotent,

and division algebras. The principal theorem on algebras is proved in a rigorous exposition as preparation of quadratic numbers, reducible polynomials, and the normal form of integral algebraic numbers. Then comes the chapter on the Arithmetic of an Algebra which include generalized quaternions and application to Diophantine equations. The last chapter deals with the properties of fields. The exposition is clear and at the same time rigorous.

Co-ordinate Geometry by Luther Pfahler Eisenhart (pp. 298, price \$ 1.65). Mr. Eisenhart's work is well known to students of mathematics, as affording a thorough, complete and unified introduction to the subject. The large number of exercises throughout the text will prove particularly helpful to students.

Differential Equations for Engineers by Philip Franklin (pp. 300, price \$ 1.65) will be useful for physicists, engineers and applied mathematicians. Broader in scope and treatment than most books in the field, this work is an outgrowth of a course given by the author for over ten years at the Massachusetts Institute of Technology.

The Applications of Elliptic Functions by Alfred George Greenhill (pp. 357, price \$ 1.75). A basic text on the use of both elliptic integrals and functions, this book has never been excelled for careful attention to every detail of solution. Although written in 1892, the book can still be recommended to students of applied mathematics today.

These five additions to the Dover programme should prove valuable items in the library of every student of science.

Progress in Inorganic Chemistry. Edited by F. Albert Cotton (Interscience Publishers, New York, London), Vol. I. 1959. Pp. 566 + vi. Price \$ 14.50 ; Vol. II. 1960. Pp. 399. Price \$ 10.50.

It has become increasingly difficult for both an academician and an industrial chemist to keep abreast with the advances that are being made in the field of Inorganic Chemistry which has grown so wide that it has become very hard to define what constitutes "Inorganic Chemistry". The variety of topics that are presented in this series will attest such a difficulty. As the Editor has rightly pointed out in his Introduction, the scope of Inorganic Chemistry has expanded considerably in recent years to include the organo-derivatives, mixed oxide systems, quantum mechanical treatment of spectral and magnetic properties, and catalytic

tically active surfaces, in addition to the preparation and a study of properties of a host of new compounds by classical methods. The tentacles of inorganic chemistry have thus pervaded into the various branches of physical and organic chemistry with a view to correlating the electronic structure of the atom and the nature of the chemical bond with the several physico-chemical properties.

From this point of view, it is gratifying to note that in the first volume considerable space in the contributions is devoted to give a critical survey of the structural features of the compounds employing various modern techniques. In fact in some cases even the classification of the compounds is based on the structural considerations. The correlation of the physico-chemical properties of the compounds with the nature of the chemical bond and the electronic structure of the atom has placed the vast experimental data on a logical basis.

The authors of the several contributions to these volumes are active research workers who are well known in their fields of specialisation and have given authoritative accounts of the various topics along with up-to-date references for further reading.

The first volume deals with the following topics : (1) Cyclopentadienyl and Arene Metal Compounds, by G. Wilkinson and F. A. Cotton ; (2) Interstitial Compounds of Graphite by G. R. Hennig ; (3) Über-Schwefel-Stickstoff-Verbindungen, by Margot Becke-Goehring ; (4) Metal-Ammonia Solutions, by W. L. Jolly ; (5) Iso-cyanide Complexes of Metals, by L. Malatesta ; (6) The Effect of Inner Orbital Splitting on the Thermodynamic Properties of Transition Metal Compounds and Co-ordination Complexes, by P. George and D. S. McClure ; (7) The Structure and Properties of Mixed Metal Oxides, by R. Ward.

The seven topics dealt with in the second volume are : (1) Radioactivation Analysis in Inorganic Geochemistry, by John W. Winchester ; (2) Halides and Oxyhalides of the Elements of Groups Vb and VIb, by John W. George ; (3) Extraction of Inorganic Compounds into Organic Solvents, by R. M. Diamond and D. G. Tuck ; (4) Some Fluorine Compounds of the Transition Metals, by R. D. Peacock ; (5) Intensities of Spectral Bands in Transition Metal Complexes, by C. J. Balhausen ; (6) Unusual Oxidation States of Some Actinide and Lanthanide Elements, by L. B. Asprey and B. B. Cunningham ; (7) Metal Alkoxides, by D. C. Bradley.

In an attempt to make the volumes international in character, it has been suggested that contributions might appear in English, French or German depending upon the proficiency of the author in the language, but the reviewers are of the opinion that the utility of the contributions would be enhanced if all the articles appear in English. There is no doubt that these volumes will be found very useful both to the research worker in the field and to the University teacher dealing in advanced topics in Inorganic Chemistry.

M. R. A.
A. R. V.

Radioactivity for Pharmaceutical and Allied Research Laboratories—A Symposium Sponsored by Nuclear Science and Engineering Corporation. Edited by Abraham Edelmann. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xii + 171. Price \$ 6.00.

The employment of radiation techniques in solving the problems of the pharmaceutical and related industries has been rather limited so far. This volume, presenting the proceedings of a Symposium, deals with the principles, methods and areas of usefulness of radioactivity in the pharmaceutical and allied sciences. Problems one has to face in pioneering a new technology have been vividly described. Development of electron beam irradiation process for sterilizing surgical sutures, application of isotope dilution techniques to the analysis of drugs as exemplified by γ -isomer content in benzene hexachloride and determination of penicillin G in fermentation broth, biosynthesis and metabolic studies of C¹⁴ oxytetracycline, evaluation of the tranquilizer, reserpine and use of radioisotopes in soap, detergent and cosmetic research are but a few illustrations of the potential usefulness of radioactivity.

Development of a bioassay technique for granulocytopenia, production of cataracts and the phenomenon of accelerated ageing as a result of ionizing radiations depict how even the adverse effects by biological radiations could be used as experimental models for evaluating drugs and studying the problems of gerontology. The isotope development programme of the U.S. Atomic Energy Commission, detailed in the last chapter, reveals the increasing interest evinced and the measures taken in expanding the industrial uses of radioisotopes.

M. SIRSI.

Harb. I.M.I. Handbook: By J. C. F. Hopkins and others. (Commonwealth Mycological Institute, Kew, England), 1960. Pp. 103. Price 12 sh. 6 d.

We welcome this delightful little handbook of methods in use at the Commonwealth Mycological Institute. For those of us, like the reviewer, who had the privilege of working at the C. M. I. for sometime, most of the techniques and procedures described in this book are familiar and have always been the focus of admiration. However, many mycologists and plant pathologists are not familiar with these and the publication of this handbook is therefore an event of great importance. Even, in the Herb. Crypt. Indiae Orientalis at New Delhi, few of the methods outlined here are followed, although it is India's oldest mycological Herbarium. This book is particularly recommended for reading by those in charge of this Herbarium and others in charge of smaller Herbaria in other Institutions in India. Indeed, everyone interested in the study of fungi, in establishing and building up a Herbarium, and in maintaining established ones, will find in this book clear and precise descriptions of the techniques and procedures which they need and should follow.

Dr. Hopkins (Director, C.M.I.) introduces the book, with a dedication to Mr. E. W. Mason (former Mycologist) which is very appropriate. It is perhaps no exaggeration to say that most of the techniques or procedures evolved at the C.M.I. were inspired by him during his long association with the Institute. In the introductory chapter, Dr. Wiltshire (former Director) covers the entire range of the activities of the Institute in contributing to our knowledge of fungi and in serving the needs of plant pathologists and of pure and applied mycologists all over the world. This is followed by chapters on "The Herbarium" by Dr. M. B. Ellis, "How to describe a fungus" by Dr. F. C. Deighton, "Laboratory methods used in the culture collection" by Major H. A. Dade, "The treatment of important pathogenic Phycomyctes" by Dr. G. M. Waterhouse, "Bacteria and the Herbarium" by Dr. A. C. Hayward, "Collecting fungi" by Dr. C. Booth, "Collecting in the tropics" by Dr. Deighton, "Collecting in the clinic" by Dr. G. C. Ainsworth, "The Index of Fungi" by Dr. Deighton, "The Bibliography of Systematic Mycology" by Dr. Waterhouse, "The Herbarium and the Review of Applied Mycology" by Dr. E. B. Martyn, and "The Review of Medical and Veterinary Mycology and the Herbarium" by Dr. Ainsworth. A list of the

C.M.I. staff and of C.M.I. publications is appended.

Students, teachers, research workers and even professional plant pathologists and mycologists would be able to learn much by a reading of the different chapters of this book. A special tribute, however, is paid here to the chapter on Culture Collection Techniques by Major Dade which is admirably written in typical "Dadean" fashion and provides delightful reading. It is a most instructive chapter worth reading repeatedly since it contains details of techniques which every mycologist should be familiar with. It could not have been written better by any one else. A similar tribute is paid here to the chapter on Herbarium by Dr. Ellis. The chapter on pathogenic phycomycetes by Dr. Waterhouse reflects the interest in pathogenic forms and perhaps it would have been most useful if the techniques for the isolation of other aquatic forms had also been elaborated a little more, although it must be admitted that a reference has been made to Emerson's excellent paper in *Mycologia* (1958, 50, 589). I am sure, like the useful and indispensable *Dictionary of Fungi* which first appeared in 1943, this little handbook will also grow and a second, slightly more enlarged edition will appear in due course. Even in its present form I would rank this as one of the most useful books on mycological techniques that has ever appeared.

Dr. Hopkins and the Commonwealth Agricultural Bureau are to be congratulated for bringing out this excellent book which contains the quintessence of many years' careful and critical work aimed at evolving techniques of collection and preservation of fungi, of maintenance of Herbaria and of living culture collections and also procedures for indexing the taxonomic and other literature on fungi and literature on applied mycology and plant pathology. The book is well got up and moderately priced. Everyone interested in the study of fungi should have a copy, should study it thoroughly and it would be most rewarding, if the procedures outlined are followed.

C. V. SUBRAMANIAN.

The Land and Freshwater Mollusca in the Collection of the Madras Government Museum—*Bulletin of the Madras Government Museum*, New Series, Natural History Section, Vol. VI, No. 4, 1960. Pp. 174, 21 plates.

Very few will disagree with the view that to know one's own country—its geophysical, geographical, and biological features, its peoples

and their history and culture—is itself a liberal education. Our Natural History Museums may be said to have fulfilled their paramount education function if they gather, preserve, describe, display, and interpret natural history objects found not only within the boundaries of one's country, but also determine such relations as may exist between them and their nearest congeners outside it.

The series of Bulletins of the Madras Government Museum which have been issued since 1927 contain original descriptive accounts relating to the fauna, flora, peoples, and monuments of South India, and the present No. 4 of Volume VI of the series under review is one such dealing with the land and freshwater snails and clams in the collection of the museum, and its author, Dr. S. T. Satyamurti, has explained in his introduction the need for "a clear handlist of, at least, the commoner species in their modern sequence" which would be "readily appreciated not only by students and systematists but also by amateurs who wish to collect shells of inland species, and arrange, name, and classify them in a scientific way."

The descriptive account of about 120 species of land and freshwater mollusca which covers 142 pages is followed by (1) an essential bibliography on the subject, (2) an appendix listing new records of species, and (3) an index (covering 11 pages) of not only the genera and species but also of certain common or popular words and technical terms used in the text, which are italicised.

The reviewer wishes that the original spellings of place-names had been bracketed and their modern variants added to avoid confusion, and the localities grouped according to the states to which they belong. The illustrations of species on plates are clear and helpful. The author deserves the thanks not only of all malacologists and conchologists but also of students for placing in their hands a handbook of this kind as a help towards a clearer understanding of the correct classification and relationship of the species dealt with.

H. S. R.

Nepal. By Pradyumna P. Karan (University of Kentucky Press, Lexington), 1960. Pp. 100. Price \$ 10.00.

An extensive and comprehensive survey of the tiny Himalayan kingdom of Nepal has been made by Dr. Pradyumna P. Karan in his book *Nepal*. The volume covers most aspects one can think of including the geographical features,

mineral resources and scientific potentialities set against the historical, political and cultural background of the country. The book bears evidence of the first-hand knowledge of the author and its claim to be the "first physical and cultural geography of Nepal" seems justified. The textual information is supplemented by 35 full-page maps presenting essential features regarding geography, climate, agriculture, geology, mineral resources, industry, population, health, political divisions, etc. There are also included in the book a large number of photographs which the author himself had taken. The book besides being popular will be of topical interest.

The book is well got up and printed on high-class paper $14'' \times 10\frac{1}{2}''$. The jacket in the cover contains a large-scale map of Nepal's administrative divisions showing the boundaries of the country's 491 thums (counties). This map is claimed to be the first ever made. Considering the many good features of the publication the price marked cannot be regarded as too high.

U. G.

Water and Agriculture: A Symposium presented at the Washington Meeting of the American Association for the Advancement of Science, December 1958. (Publication No. 62 of the Association, Washington D.C.), 1960. Pp. 206. Price \$ 5.00.

This publication of nearly 200 printed pages contains 17 papers contributed by recognized authorities in their own subjects. The papers have been grouped into 4 parts dealing respectively with (i) Water for the future, (ii) Water sources, (iii) Water planning and use, (iv) Technique of water control. Although the papers deal with conditions in U.S.A., some of them are of great interest to us in India where all possible steps are being taken to develop and utilize our still underdeveloped water resources to increase agricultural production.

All the papers contributed to the symposium are important but special mention may be made of some. The paper on the "beneficial effects of weather modification in augmenting water supplies and the development of techniques that will make it possible" should interest meteorologists engaged in creating artificial rains. The paper on "use of climatic data in guiding water management on the farm" shows the type of investigations that should be necessary in India to make the most efficient use of our water resources. There are also contributions on Soil Conservation practices and availability of water, Forest management in increasing water yields,

and Agricultural Drainage. The book deserves a careful perusal as it contains valuable information of interest to both Agricultural Scientists and Irrigation Engineers.

K. R.

Cotton in India : A Monograph, Vol. II. (Issued by the Indian Central Cotton Committee), July 1960. Price Rs. 30 or 45 sh.

This is the second volume of a series of four programmed, and the first volume appeared in February 1960 and was reviewed in November issue of *Current Science*. The present volume deals in five chapters with Physiology, Agronomy, Diseases, Insect and Mite Pests and Seed Multiplication and Distribution.

Part of the information on Physiology had already appeared in the *Scientific Monograph No. 3* of the Indian Central Cotton Committee. Spacing as affecting the development and production in the American cotton grown under varying conditions is discussed and its importance stressed. The role of micronutrients is briefly dealt with, and it is shown, that in soils alkaline in reaction, application of chromium, zinc and manganese increases yields. Experiments with chemical hormones have shown that MAA applied at the reproductive phase gives significant yield increases in *desi* cotton. The physiological causes of bud and boll shedding are still unknown. It is clear that there is still considerable lacuna in our knowledge on the physiology of cotton needing intensive studies.

The chapter on Agronomy mentions the advantages of early sowing, of the growing of a leguminous crop preceding cotton in the rotation and mixed cropping in tracts of low rainfall. The general tillage and cultural practices followed in different cotton areas of India are described and a summary is given of the results of manurial experiments. These results indicate the value of nitrogen and also the optimum period of application to *desi* and American cotton grown in different areas. Information is given on the optimum quantities of water needed by American and *desi* cotton and also when to irrigate. A list of improved varieties of cotton and their characteristics is given in the end which rather appears out of place and could well have gone into the last chapter dealing with seed. This is the only chapter in the book which is purely descriptive without reference to experimental data and literature, and could have been more suitable for a popular treatise.

The chapter on cotton diseases gives a good description of all the known diseases of cotton caused by fungus, bacteria and nematode, their

symptoms, etiology and control measures. Similarly, the chapter on insect and mite pests provides detailed information on the life-histories of the various pests, their natural enemies, their alternate hosts and control measures. There is a long list of the pests occurring on cotton, in different states given at the end. Critical information on the relative importance of the different pests in particular areas and the usual time of their occurrence would have proved much more valuable.

The last chapter on seed multiplication and distribution gives a good account of the early history of cotton-seed schemes in the country, and how the Indian Central Cotton Committee since its inception has been supporting seed schemes with financial help to states. The technique of multiplying seed is described and reference could have been made to Harland's elite method. There has been remarkable progress since the Plan period both in total production and in the production of long staple cotton. The latter which formed only 15% of production in 1947-48 has gone up to 41% in 1956-57. The area covered by improved varieties has also progressed which was 72% in 1956-57. There has been further additions to the list of improved varieties since the monograph was written.

There is a difference between Volume I and Volume II in that the subject-matter of the latter is all handled by men who are active workers in the particular fields. A perusal of Volume I by one acquainted with cotton research in India created an impression that in the compiling of the information the authors of particular chapters had not given due credit to the earlier workers in the field. The present volume is however free from such criticism. For the first time all available scientific information on cotton has been brought together and it clearly establishes the great progress that has been made in cotton research in the country.

K. R.

A Bibliography of Indology, Vol. 1. *Indian Anthropology*. Compiled by J. M. Kantikar, edited, revised and enlarged by D. L. Banerjee and A. K. Ohdedar, Calcutta. (The National Library), 1960. Pp. xii + 290 (two columns per page). Price Rs. 5·00.

Sri. B. S. Kesavan, Librarian of the National Library, explains that this is the first volume of a series of Bibliographies of basic publications on all aspects of Indian Culture. This Bibliography was compiled mainly from mate-

rials available in the National Library but data were also collected from many other libraries and institutions. Literature appearing in journals has, however, been 'sparingly drawn upon', because other Bibliographies, such as the one compiled by Elizabeth von Furer-Haimendorf, have devoted considerable attention to it. Most of the entries in the Bibliography under review are annotated with carefully selected quotations from reviews, prefaces or forewords. The result is a useful compilation. Within the limits deliberately set by those who planned the volume, this Bibliography amply achieves the intended purpose. The data have been carefully grouped, first region-wise and then subject-wise. Exhaustive author and subject indexes at the end increase the usefulness of the book.

The book is good value at five rupees, but this reviewer wishes that more durable binding than cardboard had been used. In a book of this kind which is expected to be in regular use, binding is of the utmost importance.

The National Librarian and his staff deserve our thanks for a timely and useful publication. We will look forward to other volumes in this series with great expectation. T. N. MADAN.

Books Received

An Introduction to Astrodynamics. By Robert M. L. Baker Jr. and Maud W. Makemson. (Academic Press Inc. Pub., New York 3, N.Y.), 1960. Pp. xiv + 358. Price \$ 7.50.

Beautiful Climbers of India. By B. P. Pal (Indian Council of Agricultural Research, New Delhi-12), 1960. Pp. 105. Price Rs. 8·00.

The Ethical Animal. By C. H. Waddington. (George Allen & Unwin Ruskin House, London W.C. 1), 1960. Pp. 230. Price 25 sh.

The Nature of the Universe. By Fred Hoyle (Macmillan & Co. Ltd., London W.C. 2), 1960. Pp. vii + 103. Price 8 sh 6 d.

Biochemical Society Symposia—No. 19—Steric Aspects of the Chemistry and Biochemistry of Natural Products. (Cambridge University Press, London N.W. 1), 1960. Pp. vii + 137. Price 20 sh.

Cotton in India—A Monograph, Vol. III. By C. Nanjundayya, R. L. N. Iyengar. et. al. (Indian Central Cotton Committee, P. B. No. 1002, Bombay-1), 1960. Pp. viii + 295. Price Rs. 30·00.

Homology Theory—An Introduction to Algebraic Topology. By P. J. Hilton, S. Wylie. (Cambridge University Press, London N.W. 1), 1960. Pp. xv + 484. Price 75 sh.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Annamalai University has awarded the Ph.D. degree in Chemistry to Miss M. Uma for her thesis entitled "A Study of Some Steric and Polar Effects by Spectral and Dipole Moment Measurements".

Indian Botanical Society

The following were elected as Office-bearers of the Society for the year 1961 : President and Hon. Secretary : Prof. J. Venkateswarlu, Waltair ; Vice-Presidents : Dr. I. I. Banerji, Calcutta, Prof. P. N. Mehra, Chandigarh ; Hon. Treasurer and Business Manager : Prof. T. S. Sadashivan, Madras. The Editorial Board for the year 1961 will consist of : Rev. Fr. H. Santapau, Prof. P. Maheshwari, Dr. B. P. Pal and Prof. R. Misra.

Regional Seminar on Scientific Documentation in South Asia

The UNESCO South Asia Science Co-operation Office (SASCO) is organizing a Regional Seminar on Scientific Documentation, March 7-16, 1961, at the Indian National Scientific Documentation Centre (INSDOC), National Physical Laboratory, Hillside Road, New Delhi. The Government of India have kindly offered to act as host to this Seminar.

The Seminar will consider the needs of countries in Asia for scientific documentation, survey the nature and scope of existing scientific documentation facilities in Asia and their availability for use in the region, consider the facilities obtaining areas outside South and South-East Asia which may be useful to assist further developments in the region, consider the selection and training of personnel and the problem of equipping centres and make recommendations for future improvement of scientific documentation work in the region.

Further particulars can be obtained from the UNESCO South Asia Science Co-operation Office, 21, Curzon Road, New Delhi.

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board Fellowships for the year 1961 have been awarded to the following candidates : Sri. A. Irudayam, State Forensic Sciences Laboratory, Madras ; Dr. Naunehal Singh, All-India

Institute of Medical Sciences, New Delhi ; Dr. Prasanta Basu, Institute of Postgraduate Medical Education and Research, Calcutta ; Miss Chitra Roy, Indian Cancer Research Centre, Parel, Bombay-12 ; Shri A. K. Deb, Indian Institute of Science, Bangalore-12 ; Shri T. N. Pattabiraman, Christian Medical College Hospital, Vellore.

18th International Congress of Pure and Applied Chemistry

The 18th International Congress of Pure and Applied Chemistry will be held in Montreal, Canada, from August 6 to 12, 1961.

Plenary lecturers who have accepted to participate are : Prof. F. S. Dainton, England ; Prof. R. Daudel, France ; Prof. G. Schwarzenbach, Switzerland ; Prof. R. H. Wilhelm, U.S.A. ; and Academician N. N. Semenov, U.S.S.R.

Some 70 sectional lectures will be delivered on the various aspects of the following four divisions of chemistry with which the Conference will deal : I. *Physical Chemistry* : (a) Structure and Reactivity of Small Molecular Species, (b) Solid State, (c) Chemical and Thermodynamic Properties at High Temperatures, (d) Nuclear Chemistry ; II. *Applied Chemistry* : (a) Structure and Catalytic Activity of Metal Surfaces, (b) Metallurgical Processes, (c) Electrochemistry, (d) Plastics and High Polymers, (e) Wood Chemistry Symposium (invited papers only) ; III. *Analytical Chemistry* : (a) Analysis of Metals and Minerals, (b) Analytical Chemistry of the Less Common Metals, (c) Analysis of Pesticide Residues ; and IV. *Organic Chemistry Symposium* : Dynamic Stereochemistry (invited papers only).

Hydrospheric Origin of Lunar Surface Features

The large and smooth appearance of the lunar maria has generally been viewed as sufficient evidence to identify their surfaces as lava flows. The arguments for lava presuppose the absence of a lunar atmosphere or hydrosphere lasting any significant length of time. However, during the past few decades geophysical as well as geological investigations have made clear that the present atmosphere and hydrosphere of the Earth are not residual from primordial antecedents, but are almost of secondary origin, being formed by exudation from the Earth's interior.

In an article contributed to *Nature* (1960, 188, 886), J. J. Gilvarry considers the possibility of an analogous process in the case of the Moon, and advances arguments to show that the origin and nature of major surface features on the Moon can be explained in terms of effects of the former presence of a lunar hydrosphere.

Gilvarry shows that such a lunar hydrosphere existed and lasted for a period at least of the order of 10^9 years, which is comparable with the duration (about 4.5×10^9 years) of the Moon's lifetime. The maximum depth of the lunar hydrosphere has been estimated as about 2 km. This shows that sufficient water existed in the lunar hydrosphere to drown all the lowlands and to encroach significantly on the highlands, at one time.

If the Moon possessed an appreciable hydrosphere throughout a large fraction of its history, it follows that the level floors of the maria were formed by sediments deposited from the water in the course of its dissipation. Compaction of these should yield a softer rock than that forming the highlands, and this circumstance should be reflected systematically in the features characterising the different classes of lunar craters.

Gilvarry has made a detailed analysis of the different classes of lunar craters and shows that if Baldwin's curve relating crater depth to diameter (see *Curr. Sci.*, 1960, 29, 205) is extended to include the effect of crater formation in hard or soft rock, it is observed that of the lunar craters in Class I, 80 have been classified as Class I (h), occurring in the highlands, and 84 as Class I (s), occurring in the floors of the maria. This extension when applied to terrestrial craters also brings out their division into two classes, for hard and soft rocks respectively.

The presence of a lunar hydrosphere of the age calculated (10^9 years) yields a direct explanation of the various crater features observed, the origin of the maria, and the nature of the maria floor. Further it will be reasonable to suppose that the existence of an atmosphere and hydrosphere for an extended time would have provided all the requirements for biopoesis and one can speculate that life originated on the Moon through the process postulated by Oparin. The existence at one time of a primitive form of life in the lunar hydrosphere would also explain the dark colour of the maria as due to organic carbon left in the sediment. The inferred presence of organic carbon in the maria and adjacent craters would explain in a natural way the recent observations by Kozyrev, of the

Swan bands of C_2 as the result of sublimation of carbon by the heat of a meteorite impact, and there is no need to invoke volcanic activity on the Moon.

A New Class of Conductive Organic Solids

A group of highly conductive organic solids has been discovered. These materials are salts of the radical-anion formed by addition of an electron to tetracyanoquinodimethan (TCNQ). In combination with a variety of cations, the $(TCNQ\cdot)^-$ radical-anion forms two series of salts having the compositions $M^+(TCNQ\cdot)^-$ and $M^+(TCNQ\cdot)^-(TCNQ)^0$, respectively. In both type of salts the band formed from the lowest normally unfilled molecular orbital of the TCNQ is partially filled, being half-filled for the first series of salts and one-quarter filled for the second. As a result of the relatively weak intermolecular interactions characteristic of molecular crystals this band will be quite narrow. In addition, both the bandwidth and the exchange coupling of the odd electron appear to be strongly influenced by the nature of the cation M^+ , and by whether or not $(TCNQ\cdot)^0$ is present in the crystal. These features make the substances uniquely suitable for experimental study of electronic conduction and interaction in solids.—(*Phys. Rev. Letters*, 1960, 5, 503.)

Calculating the Age of Meteorites

Results of high-energy nuclear experiments conducted at the Joint Nuclear Research Institution in Dubna near Moscow, have enabled Russian scientists to confirm the hypothesis that isotopes of the gases neon and argon, constituting part of iron meteorites and differing from their counterparts on earth, are formed as a result of the disintegration of the iron nuclei by cosmic rays. This has been made possible by creating similar conditions for pure iron in the bombardment experiment in the laboratory, as meteorites are known to experience during their cosmic flight. For this purpose the iron was bombarded by protons on the synchrocyclotron of the Institute, with an energy resembling the conjectured energy of the cosmic rays, namely 660 Mev.

As a result of the bombardment all nuclei, knocked out of an iron meteorite in space under the impact of cosmic radiation, were obtained in laboratory conditions along with neon and argon isotopes. Among them were beryllium 10, cobalt 60, chlorine 36, and aluminium 28. These results indicate another possibility of

calculating the age of meteorites, and the time since they fell on earth. Moreover, these experiments determine the most probable energy of cosmic rays which meteorites encounter in outer space.—(USSR News.)

Nature of Tooth Enamel Protein as Shown by X-Ray Diffraction

Results of recent investigation by X-ray diffraction method seem to confirm that the tooth enamel protein has a keratinous and not a collagenous nature. Tooth enamel is the hardest tissue of the human body. It is far more densely calcified than bone, consisting of more than 96% of orientated hydroxyapatite crystallites embedded in an organic matrix the weight of which, when dry, amounts to roughly 0.5%. The enamel being produced by cells of ectodermal origin it was generally believed that the organic matter must be of a keratinous nature, but investigations on the amino-acids of the enamel protein created some doubts, as its hydroxy-proline content suggested some affinity with collagen. Moreover, the sulphur-containing amino-acid cystine was present in much smaller amounts than in keratins.

It is clear that an intimate connection must exist between the apatite crystal structure and the repeat of molecular building units in the enamel protein. Only then is it plausible that a mass of very small apatite crystallites can be cemented together to such a rigid texture as tooth enamel shows.

Study of X-ray diffraction patterns of tooth enamel protein will enable the measurements of repeat distances and thus allow the nature of the protein to be established. W. G. Perdok has reported the results of preliminary X-ray diffraction study of tooth enamel protein (*Proc. Roy. Neder. Acad.*, 1960, 63, 627). A successful decalcification method was devised by which the organic matrix could be separated in a state and concentration suitable for X-ray diffraction patterns to be obtained. It was observed that the patterns were similar to the fibre patterns of wool and calf's tendon.

The pattern shows an equatorial arc of 13.5 Å and an equatorial diffuse spot of 9.5 Å, these spacings being close to respectively 3× and 2× the backbone spacing of the keratins: 4.65 Å. In collagen the corresponding spacings are 12 and 4.4 Å. However, in the tooth enamel pattern the strong and characteristic equatorial reflection of β-keratin at 4.65 Å is missing. The meridional reflections show a sharp arc indicating a chain repeat of 19.9 Å (6× characteristic fibre repeat of β-keratin 3.33 Å), and a diffuse

spot of 7.0 Å. The fibre repeats of collagen are 8.9 and 2.87 Å. These results support the histological evidence from enamel development studies that the tooth enamel is keratinous in nature. However, as the X-ray patterns lack some characteristic reflections of α-, as well as β-keratin the dental keratin may be called δ-keratin.

Ferrielectrics

Sodium vanadate and sodium niobate are known to be antiferroelectric. They do not exhibit ferroelectric behaviour at low field strength in their pure state. However, it has been found that the mixed crystal sodium vanadate-niobate, represented by the general composition $\text{Na}(\text{V}_x\text{Nb}_{1-x})\text{O}_3$, exhibits ferroelectric behaviour. It shows an antiferroelectric Curie point at 375° C. and a ferroelectric behaviour below 225° C. These transition points vary slightly with the composition.

Mixed crystals produced up to a 50-50% composition are cubic and transparent with clear-cut shiny faces. They have easy cleavage planes and show large homogeneous domain areas. Results of ferroelectric behaviour show that coercivity as well as polarization of the crystals are dependent on composition. As the vanadate substitution increases coercivity decreases, and saturation polarization increases.

Like sodium niobate silver niobate is also known to be antiferroelectric. The composition $(\text{Na}_{1-x}\text{Ag}_x)\text{NbO}_3$ was also investigated and similar results were obtained exhibiting excellent hysteresis loops, and transients.

Using the three antiferroelectrics of the niobate group, a few batches of the multicomponent system described by the general formula $(\text{Na}_{1-y}\text{Ag}_y)_{1-z}(\text{Nb}_{1-x}\text{V}_x)_z\text{O}_3$ were also prepared. These compositions gave good crystals which showed ferroelectric properties similar to the above.

These studies show that the materials composed of two antiferroelectrics, the dipoles of which however are unequal, exhibit strong dipole-dipole interaction resulting in the onset of the ferroelectric state at a maximum applied field. This new group of materials with ferroelectric properties may be called "ferrielectrics" because of its analogy with ferrimagnetic materials.

It is assumed that other materials composed of sublattices with interlaced unbalanced antidipole structure representing an incompletely compensated antiferroelectric material may also exhibit ferroelectric behaviour.—(*Phys. Rev.*, 1960, 120, 1670.)

collision of pions with nucleons, nucleons with nucleons, and the production of strange particles by pions on protons. One important result that has been established at Dubna is that there is an increase in the production of K-meson pairs with an increase of energy of the primary particle.

Four invited papers were presented at the plenary session on Theories of elementary particles. This session naturally evoked considerable discussion. There always remains the question whether all the elementary particles of today are really 'elementary' or 'basic'. They are recognised as elementary on the basis of our present knowledge of nature. They may not stand as the most basic elements of matter at the next stage of physics. In fact, Fermi and Yang pointed out, as long ago as 1948, a possibility of explaining the π -meson as a compound state of a nucleon and an anti-nucleon. One of the current problems of particle physics on the mathematical side is to evolve a unified theory of fundamental particles. Ohnuki (Japan) spoke on the extension of Sakata's composite model of elementary particles. One interesting outcome of Ohnuki's investigation is the existence of a neutral meson with zero isotopic spin. This has been called π^0 . It comes out as one of the configurations of the composite model of one baryon and one antibaryon system. Any experimental evidence for this pseudoscalar meson has not so far been found.

Blokhintsev presented some new results obtained by his group at Dubna by the New functional methods in the field theory. Heisen-

berg reported on the progress of research on the non-linear spinor theory carried out during the year by his theoretical group at Munich. The chief assumption in this attack of the problem is that the symmetry principles rather than the particles themselves are regarded as the elementary notions of physics.

The above summary, though cursory, is sufficient to indicate the voluminous work that is being done on many fronts on the physics of high energies. There is no doubt that the delegates to the Conference obtained quite a lot of new information both on the experimental and the theoretical sides of the various problems connected with high energy physics. As a result of the discussions while many doubts were cleared, some were also deepened. After all, "one criticizes, one learns, gets information, and thereby the progress of science is maintained".

The full Proceedings of the Tenth Conference have been published as an impressive volume of 900 pages.* It will be clear that with this growing activity in this field of particle physics one year interval will be too short a period to understand the full implications of the results obtained and to draw definite conclusions therefrom for presentation. In this context the decision of the IUPAP to hold the Conference on a biennial basis will be welcomed.

The Eleventh Conference will be held at CERN in July 1962.

* *Proceedings of the Tenth Annual International Conference on the High Energy Physics, Rochester, 1960.* (Interscience Publishers, New York-1), 1960. Pp. xxv + 890. Price \$ 13.50.

THE EARTH'S CRUST

A SPECIAL place in international geophysical research programmes is occupied by explorations of close-lying strata of the earth's mantle, the layer underlying the solid crust. The sialic zone of the earth includes the lightest rock composed of granites, gneissic and sedimentary rock. Its specific gravity is 2.8, as compared with the earth's mean specific gravity of 5.5. In continental region, the earth's crust is 25 to 40, rarely up to 60, kilometres thick. Under the ocean bottom the sialic zone is only a few kilometres thick.

The temperature in the lower layers of the earth is not uniform. In the Ukrainian crystalline shield province, for example, the temperature rises by 8.3° per every kilometre downwards and reaches some 250°C . beneath

the crust. In the volcanic Carpathian mountains the temperature rises by 35° per kilometre and beneath the crust is as high as $1,200^\circ\text{C}$.

The age of the earth and the solar system is 5,000 to 6,000 million years. The latest researches indicate that the matter of our planet has existed as a solid for at least 4,000 to 5,000 million years. The age of the oldest discovered rock is set at 3,500 million years.

The history of the earth's crust counts 16 cycles of mountain formation, folding and mineral formation, each lasting from 200 to 300 million years. The latest is the Alpine mountain-forming cycle, in which the Carpathians and the Crimean mountains appeared. This cycle began some 220 million years ago.—(USSR News.)

A New Light Amplifier Tube to Photograph Cosmic Ray Tracks

A new electronic tube, called the Astracon, enables one to photograph the faint tracks of cosmic rays as they move through a solid crystal at speeds near the velocity of light. Although cosmic rays or other high-energy particles remain within the crystal only about a billionth of a second, they leave luminous tracks which reveal their identity and behaviour. These tracks, however, are much too dim to be seen or photographed without some means of greatly increasing their brightness. This brightening is accomplished by the new light amplifier tube Astracon. The Astracon takes the incoming photons and uses them to release electrons from a light-sensitive input surface. The emitted electrons are accelerated and guided successively onto a series of thin films. At each film, an incident electron ejects five or six additional electrons, which move on to the next film. After being multiplied in this way through several stages, the electrons strike a phosphor screen similar to that in the viewing end of a television picture tube. Here they re-emit about 10,000 photons of light (in a four-stage tube) for each photon that originally entered the tube. As a result, dim "unseeable" images on the tube's input surface are increased in brightness at the output as much as several thousand times. The degree of light amplification which the Astracon provides should make the scintillation crystal an increasingly effective tool of modern physics, where it will supplement the more familiar cloud chamber and bubble chamber in nuclear and cosmic ray research.

The working of the Astracon light amplifier equipment may be described thus: The light that is generating along the path of a cosmic ray or other high-energy particle moving through the crystal is focused by a mirror system onto the input surface of an Astracon tube. The image produced by the tube then passes through a lens system which focuses it onto the input surface of a second Astracon tube. This second tube is triggered to operate only when a desired flash of light occurs in the crystal. Thus, it acts as a shutter that can be opened or closed in a small fraction of a second and also as an amplifier of light during the time it is turned on. The final image produced

by the second Astracon tube is then directed onto a photographic film, which records the pictures of the path of the particle.

The Astracon already has been used experimentally in astronomy for increasing the brightness of the images and spectra of distant stars.—(Westinghouse News.)

Radioisotopes in Biology

The present trend in biology is towards the extensive use of physical and chemical methods of investigating the basic life processes.

The outstanding achievements of physics in electronics and the study of the molecular and atomic microcosm, and of chemistry, in investigation of the structure and properties of complex substances, especially the polymers which constitute the basis of life, are leading biology into a new period in its development, that of physical and chemical biology. Research workers are now concentrating primarily on the problems of finding the physical and chemical bases of vital phenomena, constructing a firm bridge between the living organism and inorganic matter, and penetrating the secrets of the growth, reproduction, heredity, mutation and so on—at the submicroscopic, molecular level.

The answers are being sought chiefly through modern physical and physical-chemical methods of investigation. One of the most important of these methods is the use of radioactive isotopes. Now it is possible to produce radioactive isotopes of nearly all the elements that make up living organisms. The radioactive isotopes H³, C¹⁴, Na²⁴, P³², S³⁵, Cl³⁶, K⁴², Ca⁴⁵, Mn⁵⁴, Fe⁵⁹, Co⁶⁰, Zn⁶⁵, Br⁸², Rb⁸⁶, Sr⁹⁰, I¹²⁸, and I¹³¹ have become especially important in the study of life processes.

In the present survey the author has attempted to outline the main and most promising trends in the application of radioactive tracers to biochemistry, plant and animal physiology, microbiology and immunology, histomorphological research, hydrobiology, entomology, ichthyology, genetics and other biological disciplines, giving a complete picture of the use of isotopes in biology.

* Review Series No. 7, *The Application of Radioisotopes in Biology*, by A. M. Kuzin, USSR, in Russian and English, International Atomic Energy Agency, Price \$ 1.00; 6 sh.

49-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, *Current Science Association*, Bangalore-6.

Subscription Rates: India: Rs. 12-00. Foreign: Rs. 16-00; £ 1-4-0; \$ 4.00.

HIGH ENERGY PHYSICS

THE Tenth International Conference on High Energy Physics was held at Rochester from August 25 to September 1, 1960. It will be interesting to recall that the High Energy Conference, more commonly known as the 'Rochester Conference', had its origin ten years ago in 1950, as an informal seminar when Prof. Robert E. Marshak invited to Rochester a small group of specialists to discuss the newly discovered pi-mesons and their implications in nuclear problems. With the subsequent discoveries of newer fundamental particles in cosmic radiation, and with the development of great accelerators for the production and study of these particles in the laboratories the scope of this annual conference widened, and the venue of its meetings spread out. The purpose of the annual Conference whose scope now encompasses the whole field of particle physics, is to bring together representative groups of workers from high energy laboratories throughout the world, so that they may present the results of their work done during the year both on the experimental and theoretical side and have informal and comprehensive discussions on them.

The first seven High Energy Conferences were held at the University of Rochester under local auspices. In September 1957, the General Assembly of the International Union of Pure and Applied Physics created a Commission on High Energy Physics to organize the international Conference. This Commission decided to rotate the 8th, 9th and 10th Conferences among Western Europe (CERN, 1958), U.S.S.R. (Kiev, 1959) and U.S.A. (Rochester, 1960).

The 10th Conference was attended by about 350 nuclear physicists, representing laboratories from 30 countries. In all there were some 170 contributions besides 30 invited papers. To cope with this large amount of work and also to see that the participants got the maximum benefit out of the Conference, the organising Committee divided the contributions into four groups, namely, (1) Strong interactions of pions and nucleons (experimental); (2) Strong interactions of pions and nucleons (theoretical); (3) Strong interactions of strange particles, and (4) Weak interactions. The papers under each group were presented and discussed at smaller 'working' sessions, on the first two days in four simultaneous half-day sessions. There were four half-day plenary sessions on the last four days at which rapporteurs summarized the highlights of the material presented at the

simultaneous sessions. Also there were three half-days of plenary sessions for invited papers in three fields of general interest, namely, Structure of elementary particles; New results at superhigh energies; and Theories of elementary particles. Ample time was provided for discussions which formed the more important feature of the Conference.

On the experimental side on the strong interactions of pions and nucleons, two experiments to measure the lifetime of the neutral pion were reported. The first of these by Tollestrup and his collaborators of the California Institute of Technology, was based on observation of the photoproduction process in the Coulomb field using 900 MeV photon. This gave for the π^0 lifetime a lower limit value of 5×10^{-17} sec. The second experiment, by Glasser *et al.* of the Naval Research Laboratory, was based on a direct measurement of the π^0 decay distance which gave the mean lifetime as $(2.3 \pm 0.8) \times 10^{-16}$ sec.

Valladas gave a summary of the most recent measurements of total cross-section of pion proton scattering made with the proton synchrotron at Saclay, in the energy region 400 MeV to 1.5 GeV. The Saclay results for energy and cross-section at maxima are: 605 ± 5 MeV, $\sigma = 45.8 \pm 1.8$ mb.; 890 ± 9 MeV, $\sigma = 58.0 \pm 1.8$ mb. There are small differences between the results of Saclay and Berkeley which have not yet been understood. The chief object of all these experiments, of course, is to help in assigning definite angular momenta and parities to the states which are especially important near the sharp maxima in the total cross-section. The Saclay data are consistent with the assignments of $d_{3/2}$ and $f_{5/2}$ to the states associated with the maxima at 600 MeV and 900 MeV respectively.

During the past year considerable interest, both theoretical and experimental, has centred on the question of the strength of interaction between a pair of pions. The main problem in the application of dispersion theory to pion-physics is to obtain explicit forms of the scattering amplitudes which satisfy unitarity and have the correct location of the singularities in the kinematical invariant variables.

At the Conference three different programmes were presented. Chew gave a description of his own work with Mandelstam on the pion-pion interaction carried during the year at Berkeley. This work was along the lines reported in Kiev, concentrating attention on the

type of solution in which the P-phase shift may be large at low energies.

The programme of the European group at CERN was presented by Cini and Fubini. In both these methods the equations obtained at the end are essentially the same although the procedures are different, and the approximations which are necessarily to be introduced are done at different stages. Details of studying the problem by an entirely different method were presented by Shirkov (Dubna). The two approximations that are usually made in the derivation of integral equations from dispersion relations and the unitary condition are, firstly, the two-particle intermediate approximation, and secondly, consideration of low angular momentum waves only,—the contribution from the higher angular momentum states being usually neglected. While these approximations can be justified in low energy phenomena, one has to be careful in neglecting the higher waves in what may be called the ‘unphysical’ region where it may lead to large errors. The Dubna programme outlines a new method of approach in which only those angles are chosen for deriving integral equations, for which the Legendre expansion fails only at the distant part of the unphysical region. The data calculated on this method seem to give evidence of s-wave scattering, although about p-wave scattering they are inconclusive.

Three papers presented on the experimental side of pion-pion scattering also evoked considerable interest and discussion. Since one cannot make a target of free pions, one possible experimental approach is to look for particular correlations between a pair of pions produced in the final state of some reaction. Crowe and his collaborators (Berkeley) studied the reactions $p + d \rightarrow He^3 + \pi^\circ$ ($\rightarrow He^3 + \pi^+ + \pi^-$), using incident proton energies ranging from 624 to 743 MeV. The He^3 momentum spectra show besides high momentum peaks due to π° production, a continuum at lower momentum which may be attributed to double pion interaction. Derado who studied the process $\pi^- + p \rightarrow \pi^- + \pi^\circ + p$, at 1 BeV using a hydrogen bubble chamber found a low energy peak in the kinetic energy spectrum of the proton which he has interpreted in terms of a pion-pion correlation. A similar interaction was studied by Anderson *et al.* (Berkeley) following the suggestion of Chew and Low. They reported the results of their study of photographs taken with the 72-inch hydrogen bubble chamber which was exposed to a Bevatron π^- -beam of 1.03 BeV/c.

From the contributions made at the Conference on the experimental results of the strong interaction of strange particles one may conclude that the past year has been reasonably productive from the point of view of data accumulation but quite unproductive from the point of view of real understanding. For the first time results at very high energies, above 3 BeV were presented both from the Russian accelerator and the CERN accelerator. In addition there have been some new results in proton-proton production and photo production of strange particles.

The Dubna studies on the production of strange particles by 7-8 BeV pions in a propane chamber have yielded the following measurements of total cross-sections : $\sigma(Y^\circ + K)$

$$= 0.8 \pm 0.25 \text{ mb} ; \quad \sigma(K^\circ + \bar{K}^\circ) + \sigma(K^\circ + K^-) \\ + \sigma(\bar{K}^\circ + K^+) = 12 \pm 0.3 \text{ mb}.$$

Good (Wisconsin) reported the results of his study of the reaction $K^- + p \rightarrow \Lambda + \pi^- + \pi^+$. The structure of the momentum spectra of the pions suggests the existence of quasi-stationary states of the $\pi - \Lambda$ system.

Panofsky gave a review of the work in progress on the collision of very high energy electron beams produced in the Stanford linear accelerator. The energy involved will be several thousand BeV, and it is expected that the results will be one of great significance as they will enable one to examine the validity of quantum electrodynamics in an energy region which has so far only been accessible in rare cosmic ray events.

Regarding the investigations on weak interactions, the question of the universality of weak interactions came in for much discussion. Feynman has investigated the problem with special reference to the lifetime of the muon. From the beta-decay data of O^{14} he calculates the muon lifetime as $2.251 \pm 0.012 \mu$ sec. Gell-Mann outlined a more abstract formulation of the universality idea, which might be able to cope with the weak interactions of all particles.

In the plenary session on New results at superhigh energies, Cocconi reported on the main results obtained with the 25 GeV proton synchrotron of CERN since it went into operation on November 24, 1959. One of the unexpected results was the production of light nuclei deuterons, tritons, and He^3 in the collision of the GeV protons with the target material. Veksler reported the Dubna results on the behaviour of nuclear particles colliding at high energies with special reference to

collision of pions with nucleons, nucleons with nucleons, and the production of strange particles by pions on protons. One important result that has been established at Dubna is that there is an increase in the production of K-meson pairs with an increase of energy of the primary particle.

Four invited papers were presented at the plenary session on Theories of elementary particles. This session naturally evoked considerable discussion. There always remains the question whether all the elementary particles of today are really 'elementary' or 'basic'. They are recognised as elementary on the basis of our present knowledge of nature. They may not stand as the most basic elements of matter at the next stage of physics. In fact, Fermi and Yang pointed out, as long ago as 1948, a possibility of explaining the π -meson as a compound state of a nucleon and an anti-nucleon. One of the current problems of particle physics on the mathematical side is to evolve a unified theory of fundamental particles. Ohnuki (Japan) spoke on the extension of Sakata's composite model of elementary particles. One interesting outcome of Ohnuki's investigation is the existence of a neutral meson with zero isotopic spin. This has been called π^0 . It comes out as one of the configurations of the composite model of one baryon and one antibaryon system. Any experimental evidence for this pseudoscalar meson has not so far been found.

Blokhintsev presented some new results obtained by his group at Dubna by the New functional methods in the field theory. Heisen-

berg reported on the progress of research on the non-linear spinor theory carried out during the year by his theoretical group at Munich. The chief assumption in this attack of the problem is that the symmetry principles rather than the particles themselves are regarded as the elementary notions of physics.

The above summary, though cursory, is sufficient to indicate the voluminous work that is being done on many fronts on the physics of high energies. There is no doubt that the delegates to the Conference obtained quite a lot of new information both on the experimental and the theoretical sides of the various problems connected with high energy physics. As a result of the discussions while many doubts were cleared, some were also deepened. After all, "one criticizes, one learns, gets information, and thereby the progress of science is maintained".

The full Proceedings of the Tenth Conference have been published as an impressive volume of 900 pages.* It will be clear that with this growing activity in this field of particle physics one year interval will be too short a period to understand the full implications of the results obtained and to draw definite conclusions therefrom for presentation. In this context the decision of the IUPAP to hold the Conference on a biennial basis will be welcomed.

The Eleventh Conference will be held at CERN in July 1962.

* *Proceedings of the Tenth Annual International Conference on the High Energy Physics, Rochester, 1960.* (Interscience Publishers, New York-1), 1960. Pp. xxv + 890. Price \$ 13.50.

THE EARTH'S CRUST

A SPECIAL place in international geophysical research programmes is occupied by explorations of close-lying strata of the earth's mantle, the layer underlying the solid crust. The sialic zone of the earth includes the lightest rock composed of granites, gneissic and sedimentary rock. Its specific gravity is 2.8, as compared with the earth's mean specific gravity of 5.5. In continental region, the earth's crust is 25 to 40, rarely up to 60, kilometres thick. Under the ocean bottom the sialic zone is only a few kilometres thick.

The temperature in the lower layers of the earth is not uniform. In the Ukrainian crystalline shield province, for example, the temperature rises by 8.3° per every kilometre downwards and reaches some 250°C . beneath

the crust. In the volcanic Carpathian mountains the temperature rises by 35° per kilometre and beneath the crust is as high as $1,200^\circ\text{C}$.

The age of the earth and the solar system is 5,000 to 6,000 million years. The latest researches indicate that the matter of our planet has existed as a solid for at least 4,000 to 5,000 million years. The age of the oldest discovered rock is set at 3,500 million years.

The history of the earth's crust counts 16 cycles of mountain formation, folding and mineral formation, each lasting from 200 to 300 million years. The latest is the Alpine mountain-forming cycle, in which the Carpathians and the Crimean mountains appeared. This cycle began some 220 million years ago.—(USSR News.)

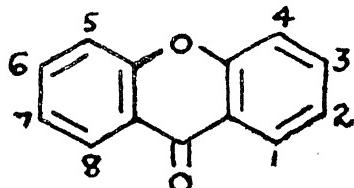
OCCURRENCE OF C₈ UNITS IN XANTHONES

S. NEELAKANTAN AND T. R. SESHADRI

Department of Chemistry, University of Delhi, Delhi-6

NATURALLY OCCURRING XANTHONES

FOR a long time only two xanthones of definite constitution, viz., gentisin (I) and euxanthone (II) were known to occur in Nature. Recently more xanthones have been found as components of important vegetable drugs and also as mould and lichen products. Some of them are reported to be physiologically active. They may have uses also as analytical reagents. The following (Table I) is a list of xanthones so far obtained from natural products. In the compounds whose structures have been more or less definitely established, an *ortho*-hydroxy carbonyl system is invariably present.



BIOGENESIS OF XANTHONES

Structurally xanthones are closely related to benzophenones and laboratory synthesis of the former is based on this relation (Chart 1).

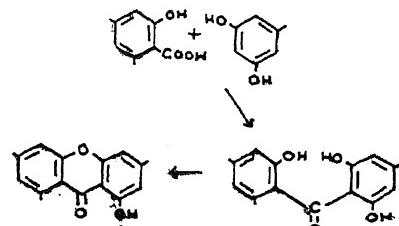


CHART 1

But with regard to their biogenesis, naturally occurring xanthones and benzophenones seem to have different lines of evolution. This is indicated by the substitution patterns of the two benzene rings present in them. The benzophenones have been considered to be derived

TABLE I

Compound	Structure	Source
1 Lichexanthone (III)	.. 1-Hydroxy-3 : 6-dimethoxy-8-methylxanthone	<i>Parmelia formosana</i> ¹ , <i>P. quercina</i> ²
2 Demethyl-lichexanthone (IV)	.. I : 6-Dihydroxy-3-methoxy-8-methylxanthone	<i>Penicillium patulum</i> ³
3 Ravenelin (V)	.. I : 5 : 8-Trihydroxy-6-methylxanthone	<i>Helminthosporium ravenelii</i> , <i>H. turticum</i> ⁴
4 Gentisin (I)	.. I : 7-Dihydroxy-3-methoxyxanthone	<i>Gentiana lutea</i> ⁵
5 Euxanthone (II)	.. I : 7-Dihydroxyxanthone	Urine of cows fed on <i>Mangifera indica</i> leaves ⁶ , <i>Platonia insignis</i> ⁷
6* Norswertianol (norswerchirin) (VI)	1 : 3 : 5 : 8-Tetrahydroxyxanthone	<i>Swertia japonica</i> ⁸ , <i>S. chirata</i> ⁹
7* Nordecussatin (norswertinin) (VII)	1 : 3 : 7 : 8-Tetrahydroxyxanthone	<i>Swertia decussata</i> ¹⁰
8 Sterigmatocystin (VIII)	.. 8-Hydroxy-1-methoxyxanthone with extra dihydro-difuran (3 : 4 : 1' : 2') system	<i>Aspergillus versicolor</i> ¹¹
9 Mangiferin (IX)	.. 2-C-Glucosyl-1 : 3 : 6 : 7-tetrahydroxyxanthone	<i>Mangifera indica</i> ¹² , <i>Salacia prinoides</i> ¹³
10 Mangostin (X)	.. 2 : 8-Di ($\gamma\gamma$ -dimethyl) allyl-1 : 3 : 6-trihydroxy-7-methoxyxanthone	<i>Garcinia mangostana</i> ¹⁴
11 Jacareubin (XI)	.. 1 : 5 : 6-Trihydroxy-(2' : 2'-dimethyl 5' : 6' : 2 : 3-pyrano) xanthone(?)	<i>Callophyllum brasiliense</i> ¹⁵
12* Nor-rubrofusarin (norasperxanthone)	1 : 7 : 8-Trihydroxy-2-methylxanthone(?)	<i>Fusarium culmorum</i> ¹⁶ , <i>Aspergillus niger</i> ¹⁷
13 Corymbiferin	.. Undetermined	<i>Gentiana corymbifera</i> ¹⁸
14 Morellin	.. do.	<i>Garcinia morella</i> ¹⁹

* These xanthones occur in Nature as their partial methyl ethers. For example, swertianol is a monomethyl ether; decussatin, a trimethyl ether; swertinin, a dimethyl ether; swerchirin, a dimethyl ether; rubrofusarin, a monomethyl ether; asperxanthone, a dimethyl ether. In the above compounds, the position of the methoxyl group has not been fully established.

from 4-phenylchromans or the corresponding coumarins²⁰ which are formed from a phloroglucinol (C_6) unit (A) and a cinnamic acid (C_9) unit (B) by the process indicated below (Chart 2). These coumarins (XII) or better the corresponding coumaric acids (XIII) seem to act as precursors and yield the benzophenones (XIV) by oxidation.

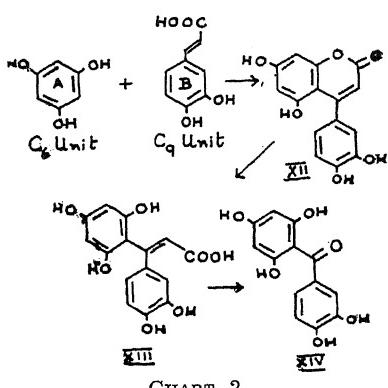


CHART 2

BIOGENESIS OF LICHEXANTHONE (III) AND RAVENELIN (V)

Of the various naturally occurring xanthones, lichexanthone (III) is a lichen product and is the simplest based on the C_8 unit origin. The presence of C_8 unit is obvious. Its biogenesis has already been discussed in an earlier paper.²¹ The formation of norlichexanthone (XV) involves a C_8 (orsellinic) unit (A) and a C_6 (phloroglucinol) unit (B) (Chart 3). Partial methylation of the more reactive 3- and 6-hydroxyl groups leads to lichexanthone (III). The formation of demethyl-lichexanthone (IV), a mould metabolic product, from norlichexanthone (XV) seems to involve monomethylation in the 3-position. This selective methylation of the 3-hydroxyl group may be significant. Of the two reactive hydroxyl groups, *viz.*, 3 and 6, which are not symmetrically located, the former seems to be more acidic because of the presence of the 1-hydroxyl group in the same ring. The exact reason for this is not at present clear.

Though ravenelin (V), a fungal product, is isomeric with norlichexanthone (XV) and is derived from similar units, it exhibits marked difference in regard to the location of the methyl and hydroxyl groups and should, therefore, have a more complex biogenesis. As indicated in earlier papers,^{21,22} the phloroglucinol part (B) has undergone nuclear reduction (loss of phenolic hydroxyl group) to a resorcinol (XVI) unit. Regarding the other part (A), 3-carboxyorsellinic acid (XVII) may be the modified orsellinic unit involved and it undergoes partial decarboxylation to *para*-orsellinic acid (XVIII). These two units (XVI and XVIII) could give rise to the intermediate xanthone (XIX). *Para*-nuclear oxidation in ring (A) of this xanthone would lead to ravenelin (V) (Chart 4). Based on these considerations, a convenient synthesis of ravenelin has recently been achieved.²²

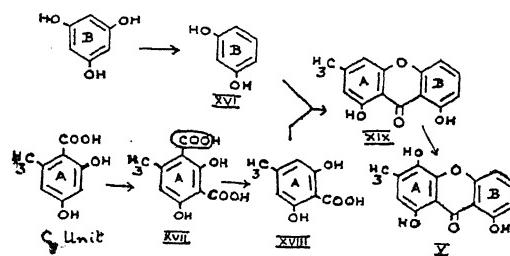


CHART 4

BIOGENESIS OF GENTISIN (I) AND EUXANTHONE (II)

The xanthones of higher plants seem to have the same evolution though their structures appear rather different. In all of them, there is a phloroglucinol (C_6) unit or the derived resorcinol unit. But instead of a simple orsellinic (C_8) unit, a modified one seems to be found. In the simpler members, gentisin (I) and euxanthone (II), a gentisic acid (XX) unit is present. In an earlier paper,²¹ the origin of gentisic acid (XX), which is a metabolic product of *Penicillium* spp., was traced to C_8 unit (Chart 5).

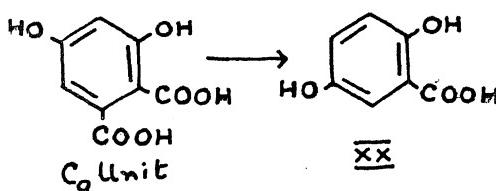


CHART 5

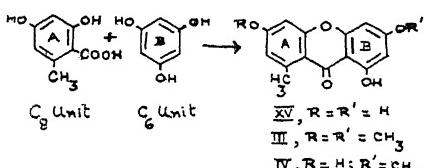
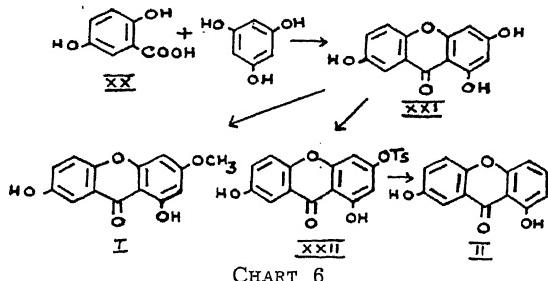


CHART 6

Gentisein (norgentisin) (XXI) may represent an earlier stage in evolution and would be the product of combination of phloroglucinol and gentisic acid (XX) (Chart 6). The formation

of gentisin (I) involves partial monomethylation of the more reactive 3-hydroxyl group.²³ Euxanthone (II) may arise from gentisein (XXI) by nuclear reduction. The laboratory conversion of gentisein (XXI) to euxanthone (II) follows this possible biogenetic pathway.²⁴ In this process, gentisein is monotosylated in the 3-position and the resulting tosyl ester (XXII) reduced with hydrogen and Raney nickel (hydrogenolysis).



BIOGENESIS OF *Swertia* XANTHONES (VI AND VII)

The *Swertia* xanthones are based on 1 : 3 : 5 : 8-tetrahydroxy-(VI) and 1 : 3 : 7 : 8-tetrahydroxyxanthones (VII). In these, one of the units (B) is phloroglucinol as in the earlier cases but the other is a 6-hydroxygentisic acid unit (XXIII). The fact that these isomeric xanthones are found in the same genera may suggest very similar origin. The following derivation of 6-hydroxygentisic acid (XXIII) from C₈ unit may be suggested (Chart 7). In this, 6-formyl-2 : 4-dihydroxybenzoic acid (C₈ unit) undergoes nuclear reduction of the 4-hydroxyl group (XXIV); subsequent para-nuclear oxidation would lead to 6-formyl-2 : 5-dihydroxybenzoic acid (XXV). Oxidation (Dakin's type) of this hydroxy aldehyde derivative would give 6-hydroxy-gentisic acid (XXIII). Similar oxidations have been shown to be important stages in the evolution of flavonoids and lichen acids and the feasibility of these under laboratory conditions has also been demonstrated.²⁵

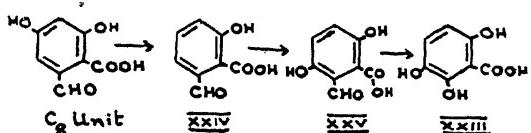


CHART 7

The isomeric tetrahydroxyxanthones (VI and VII) may arise by ring closure in two alternative directions, the former involving the 6-

hydroxyl group and the latter, the 2-hydroxyl group, respectively, of the hydroxygentisic acid (XXIII) (Chart 8).

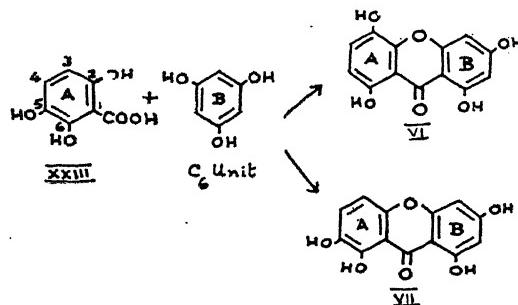


CHART 8

BIOGENESIS OF STERIGMATOCYSTIN (VIII)

Sterigmatocystin (VIII) is a derivative of 1 : 3 : 8-trihydroxyxanthone and thus has a phloroglucinol unit (B) as in a number of cases mentioned above. The other part is derived from 1 : 6-dihydroxybenzoic acid (γ -resorcylic acid). Further, there is a di-(dihydro)-furan system involving a C₄ unit probably derived from a sugar. The 1 : 3 : 8-trihydroxyxanthone may arise from 1 : 3 : 5 : 8-tetrahydroxyxanthone (VI) by a process of nuclear reduction (Chart 9). Such loss of para-hydroxyl group in quinol systems is known, e.g., 1 : 2 : 3 : 5-tetrahydroxybenzene to phloroglucinol.²⁶

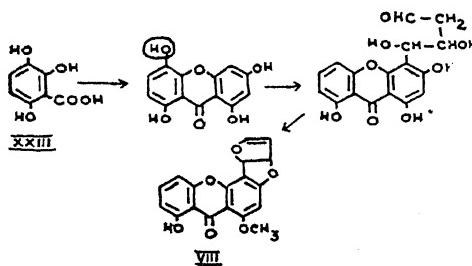


CHART 9

BIOGENESIS OF COMPLEX XANTHONES [MANGIFERIN (IX), MANGOSTIN (X) AND JACAREUBIN (XI)]

Under more complex types come mangiferin (IX), mangostin (X) and jacareubin (XI). The first two are derivatives of 1 : 3 : 6 : 7-tetrahydroxyxanthone (XXVI) and the third has a 1 : 3 : 5 : 6-hydroxy system (XXVII). In these two tetrahydroxyxanthones (XXVI and XXVII) ring (B) is again phloroglucinol and the other ring (A) may again be traced to C₈ units. The tentative suggestions are embodied in the formulae of Chart 10. In the case of 1 : 3 : 6 : 7-tetrahydroxyxanthone system (XXVI), ring (A)

of gentisin (I) involves partial monomethylation of the more reactive 3-hydroxyl group.²³ Euxanthone (II) may arise from gentisein (XXI) by nuclear reduction. The laboratory conversion of gentisein (XXI) to euxanthone (II) follows this possible biogenetic pathway.²⁴ In this process, gentisein is monotosylated in the 3-position and the resulting tosyl ester (XXII) reduced with hydrogen and Raney nickel (hydrogenolysis).

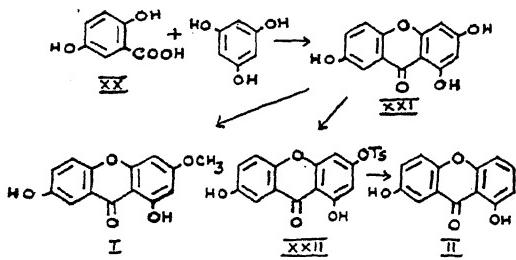


CHART 6

BIOGENESIS OF *Swertia* XANTHONES (VI AND VII)

The *Swertia* xanthones are based on 1:3:5:8-tetrahydroxy-(VI) and 1:3:7:8-tetrahydroxyxanthones (VII). In these, one of the units (B) is phloroglucinol as in the earlier cases but the other is a 6-hydroxygentisic acid unit (XXIII). The fact that these isomeric xanthones are found in the same genera may suggest very similar origin. The following derivation of 6-hydroxygentisic acid (XXIII) from C₈ unit may be suggested (Chart 7). In this, 6-formyl-2:4-dihydroxybenzoic acid (C₈ unit) undergoes nuclear reduction of the 4-hydroxyl group (XXIV); subsequent para-nuclear oxidation would lead to 6-formyl-2:5-dihydroxybenzoic acid (XXV). Oxidation (Dakin's type) of this hydroxy aldehyde derivative would give 6-hydroxy-gentisic acid (XXIII). Similar oxidations have been shown to be important stages in the evolution of flavonoids and lichen acids and the feasibility of these under laboratory conditions has also been demonstrated.²⁵

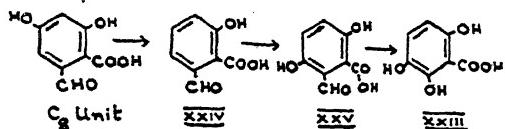


CHART 7

The isomeric tetrahydroxyxanthones (VI and VII) may arise by ring closure in two alternative directions, the former involving the 6-

hydroxyl group and the latter, the 2-hydroxyl group, respectively, of the hydroxygentisic acid (XXIII) (Chart 8).

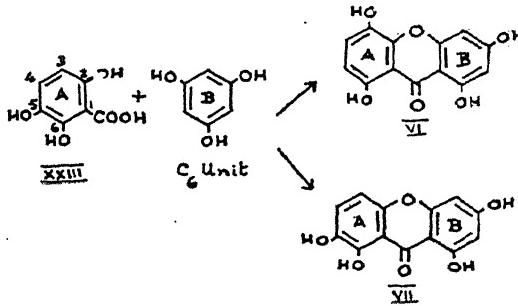


CHART 8

BIOGENESIS OF STERIGMATOCYSTIN (VIII)

Sterigmatocystin (VIII) is a derivative of 1:3:8-trihydroxyxanthone and thus has a phloroglucinol unit (B) as in a number of cases mentioned above. The other part is derived from 1:6-dihydroxybenzoic acid (γ -resorcylic acid). Further, there is a di-(dihydro)-furan system involving a C₄ unit probably derived from a sugar. The 1:3:8-trihydroxyxanthone may arise from 1:3:5:8-tetrahydroxyxanthone (VI) by a process of nuclear reduction (Chart 9). Such loss of para-hydroxyl group in quinol systems is known, e.g., 1:2:3:5-tetrahydroxybenzene to phloroglucinol.²⁶

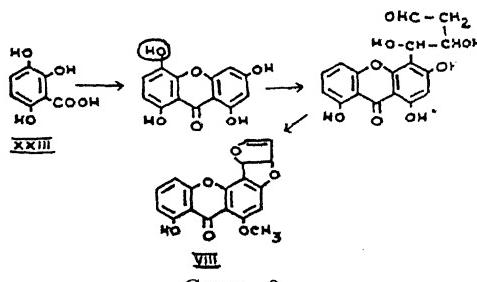


CHART 9

BIOGENESIS OF COMPLEX XANTHONES [MANGIFERIN (IX) MANGOSTIN (X) AND JACAREUBIN (XI)]

Under more complex types come mangiferin (IX), mangostin (X) and jacareubin (XI). The first two are derivatives of 1:3:6:7-tetrahydroxyxanthone (XXVI) and the third has a 1:3:5:6-hydroxy system (XXVII). In these two tetrahydroxyxanthones (XXVI and XXVII) ring (B) is again phloroglucinol and the other ring (A) may again be traced to C₈ units. The tentative suggestions are embodied in the formulae of Chart 10. In the case of 1:3:6:7-tetrahydroxyxanthone system (XXVI), ring (A)

may arise from 3:5-dihydroxyphthalic acid (DHP) (XXVIII) undergoing *para*-nuclear oxidation to 3:5:6-trihydroxyphthalic acid (XXIX). For the formation of 1:3:5:6-tetrahydroxyxanthone (XXVII), the corresponding ring may result from *ortho*-nuclear oxidation of DHP (XXVIII) to 3:4:5-trihydroxyphthalic acid (XXX). Similar reactions involving *para*- and *ortho*-nuclear oxidations are frequently met with in lichen acids.^{25,27} Further, there is loss of a single carbon atom (decarboxylation) in the 8-position of both the xanthones to yield the final products.

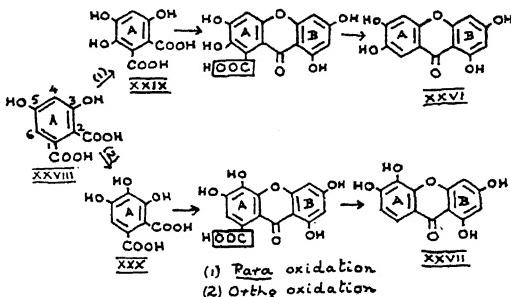


CHART 10

Mangiferin (IX) is a glucosyl derivative in which the sugar unit is linked to a carbon atom (position 2) instead of to oxygen (Chart 11). A number of examples of this type of C-glycosyl derivatives have recently been discovered.²⁸ Mangostin (X) and jacareubin (XI) are more complex and contain isoprene (C₅) units which appear to have entered the xanthone structure at a later stage.

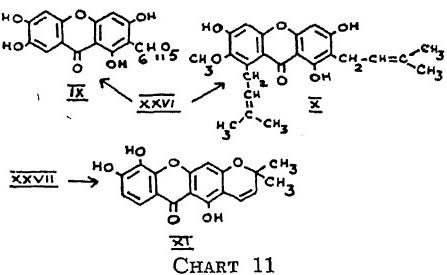


CHART 11

XANTHONES OF INDEFINITE STRUCTURE

The structure of nor-rubrofusarin was tentatively given as 1:7:8-trihydroxy-2-methylxanthone or its corresponding 1:6:7-hydroxy-isomer.²⁹ This does not fit into the above scheme of biogenesis because the methyl group is in an unusual position, *viz.*, 2-position. However, the validity of these structures has been questioned by Robertson and co-workers¹⁷ who

also found that nor-rubrofusarin was identical with non-asperxanthone. Similarly the full structures of corymbiferin and morellin have also not been established so far.

MODE OF XANTHONE FORMATION

At this stage should be discussed the mode of linking between the two units. The familiar synthetic method in which an *ortho*-hydroxy carboxylic acid is condensed with phloroglucinol or resorcinol (Chart 1) in the presence of a condensing agent may be an obvious suggestion, *e.g.*, the synthesis of lichexanthone³⁰ and gentisein.³¹ Another possible method seems to be the condensation of an *ortho*-hydroxy aldehyde (XXXI) with a phloroglucinol unit leading to a fluorone derivative (XXXII). From this to the xanthone requires an oxidation stage. For the evolution of lichexanthone (III), orcyaldehyde and for the evolution of gentisein (XXI), gentisic aldehyde would be involved. But in the laboratory adoption of this course, reduction of the fluorone (XXXII) to the corresponding xanthene (XXXIII) and subsequent oxidation yield the xanthone (XV) (Chart 12). This procedure has been used for the synthesis of lichexanthone^{1,2} (III).

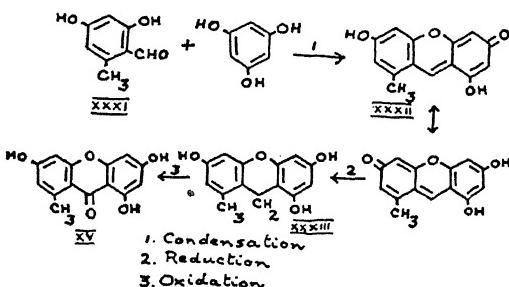


CHART 12

SUMMARY

A large number of xanthone derivatives have recently been isolated and characterized. All of them seem to be biogenetically capable of coming into a mixed type consisting of a C₆ and a C₈ unit. The simplest is represented by lichexanthone and others involve more stages of transformation. They are conveniently classified on this basis. The formation of xanthone skeleton itself could be visualized in two alternative ways involving condensation of either a carboxylic acid or an aldehyde.

1. Asahina, Y. and Nogami, H., *Bull. chem. Soc. Japan*, 1942, 17, 202.
2. Aghoramurthy, K. and Seshadri, T. R., *J. sci. industr. Res. India*, 1953, 12B, 73 and 350.

3. McMaster, W. J., Scott, A. I. and Tripett, S., *J. chem. Soc.*, 1960, 4628.
4. Raistrick, H., Robinson, R. and White, D. E., *Biochem. J.*, 1936, **30**, 1303.
5. Perkin, A. G., *J. chem. Soc.*, 1898, 672 and 1028.
6. Robertson, A. and Waters, R. B., *Ibid.*, 1929, 2229.
7. Spoelstra, D. B. and Van Royen, M. J., *Rec. trav. chim.*, 1929, **48**, 370.
8. Asahina, Y., Asano, J. and Ueno, Y., *Bull. chem. Soc. Japan*, 1942, **17**, 104.
9. Dalal, S. R. and Shah, R. C., *Chem. and Ind. (London)*, 1956, 664.
10. —, Sethna, S. M. and Shah, R. C., *J. Indian chem. Soc.*, 1953, **30**, 463.
11. Davies, J. E., Kirkaldy, D. and Roberts, J. C., *J. chem. Soc.*, 1960, 2169.
12. Ramanathan, J. D. and Seshadri, T. R., *Curr. Sci.*, 1960, **29**, 131.
13. Pillay, P. P. and Lekshmi, A., *Bull. Res. Inst. University of Kerala*, 1957, **5A** (i), 40.
14. Yates, P. and Stout, G. H., *J. Amer. chem. Soc.*, 1958, **80**, 1691.
15. King, F. E., King, T. J. and Manning, L. C., *J. chem. Soc.*, 1953, 3932; 1957, 563.
16. Ashley, J. N., Hobbs, B. C. and Raistrick, H., *Biochem. J.*, 1937, **31**, 385.
17. Lund, N. A., Robertson, A. and Whalley, W. B., *J. chem. Soc.*, 1953, 2434.
18. Ross, D. J., *Newzealand J. Sci. Technol.*, 1950, **32 B**, 39.
19. Bringi, N. V., Dave, K. G., Karmarkar, S. S., Kurth, E. F., Mani, R., Ramanathan, V. and Venkataraman, K., *Sci. Proc. roy. Dublin Soc.*, 1956, **27**, 100.
20. Seshadri, T. R., *Curr. Sci.*, 1957, **26**, 239.
21. Aghoramurthy, K. and Seshadri, T. R., *J. sci. industr. Res. India*, 1954, **13A**, 114.
22. Ahluwalia, V. K. and Seshadri, T. R., *Proc. Indian Acad. Sci.*, 1956, **44 A**, 1.
23. Rao, G. V. and Seshadri, T. R., *Ibid.*, 1953, **37 A**, 710.
24. Jain, A. C., Mittal, O. P. and Seshadri, T. R., *J. sci. industr. Res. India*, 1953, **12 B**, 647.
25. Seshadri, T. R., *Experientia, Suppl. II*, 1955, 258.
26. Posternak, T., *Helv. chim. Acta*, 1936, **19**, 1336.
27. Aghoramurthy, K. and Seshadri, T. R., *Proc. Indian Acad. Sci.*, 1952, **35 A**, 327.
28. Bate-Smith, E. C. and Swain, T., *Chem. and Ind. (London)*, 1950, 1132.
29. Mull, R. P. and Nord, F. F., *Arch. Biochem.*, 1944, **4**, 419.
30. Grover, P. K., Shah, G. D. and Shah, R. C., *J. sci. industr. Res. India*, 1956, **15 B**, 629.
31. Pankajamani, K. S. and Seshadri, T. R., *Ibid.*, 1954, **13 B**, 396.

SOLAR ENERGY

THREE are two chief methods of harnessing solar energy. The first is the direct method or the "greenhouse" method known to all horticulturists. The interior of the greenhouse heated by the sun's rays, reflects long infrared waves to which the glass is opaque. The heat of these rays is caught as it were in a trap: it cannot escape and tends to accumulate in the glassed-in space. This method, therefore, allows the sun's rays to enter through a glass surface and prevents the radiation of bodies heated by the sun from escaping. The direct method can produce temperatures up to 150° C.—however, the practical working temperatures are kept at a lower level between 60° and 80° C.

The second method is by concentration of the solar rays on suitable collectors whereby temperatures ranging from several hundred to a few thousand degrees can be obtained. Two types of collectors are generally used: (i) The 'flat' collector consisting basically of a dark plate, insulated on the side away from the sun, and protected from the wind on the side facing the sun by a transparent pane. The plate may heat either liquid-filled pipes attached to it or air. (ii) The 'focusing collector' uses mirrors in order to concentrate the sun's rays upon a small receiving object with a dark surface. In general, the focusing collectors must be continually manoeuvred to follow the sun's movement.

The design and efficiency of the collectors have been improved in recent years by the use of new materials and of darkened selective surfaces with low radiating power, thus leading to higher operative temperatures. Glass, anodised aluminium and new plastics aluminised in a vacuum have been used for focusing collectors.

A third type of collector, suitable for very large surfaces, has been studied in France and in Israel. This is the 'solar pool', a shallow basin with a darkened bottom whose operation is based upon the principle of water density. By dissolving salts in the water at the bottom of the pool, a very salty layer is obtained while the top layer remains unsalted, the difference in density preventing them from mixing. The top layer keeps an even temperature, because it loses its heat at the same rate as it stores it, but the heat generated in the salty water at the bottom of the pool does not escape and it can be used as a source of power.

Conversion of solar heat into electricity through thermocouples has reached a high degree of development, thanks to improvements resulting from basic research in solid state physics. Progress in this field of solar converters has been particularly noteworthy in US and USSR under their programme of space research.—(UNESCO).

WIND AS A SOURCE OF ENERGY IN INDIA

As the pressure of population increases and natural resources get depleted all progressive nations have to look to new sources of energy. The United Nations as well as individual nations have been lately devoting considerable time and energy to the harnessing of new sources of energy like Wind Power, Solar Energy, Tidal Energy and so on. In India too, these new sources of energy have been receiving attention in the last few years. In this context we have recently received a Review of Progress on Utilization of Wind Power issued by the National Aeronautical Laboratory, Bangalore, on the occasion of a recent meeting of the Wind Power Sub-Committee of the Council of Scientific and Industrial Research.

The project on the utilization of Wind Power in India was initiated by Prof. M. S. Thacker, and Dr. P. Nilakantan was the Investigator-in-Charge since 1952. Mr. E. W. Golding of the British Electrical and Allied Industries Association, U.K., who is an authority on the utilization of Wind Power came to India in September 1954, to attend the Symposium on Solar Energy and Wind Power held in New Delhi under the auspices of the UNESCO and CSIR. He visited various places in India and felt convinced about the great scope for Wind Power development in India, though on different scales and for different purposes in various districts. To accomplish a significant amount of development, he recommended that there should be a staff of investigators devoting full time to experimental studies of several aspects of the subject, that facilities should be afforded for both theoretical and experimental work, and that a Workshop and a Laboratory should be established. Extensive Wind Velocity Surveys in selected areas in different parts of the country have to be made. He also recommended that research should be directed in the first instance to the development of small- and medium-sized wind electric generators. These were accepted by the Board of Scientific and Industrial Research and endorsed by the Governing Body in 1957. It is gratifying to note that with a view to implement the recommendations, a Wind Power Division has been formed as a part of the National Aeronautical Laboratory which was started in Bangalore in 1960. All the necessary facilities for the development of Wind Power as recommended by Mr. E. W. Golding will be available in this Laboratory. During the few years prior to the starting of the National Aeronautical Laboratory, the small

nucleus of the Wind Power Division of the CSIR have already developed two prototype windmills suited to Indian conditions and have been fabricated using indigenous materials which on test have worked very satisfactorily. The fabrication of some of them for experiments in different parts of India under different conditions is programmed for the immediate future. Necessary experience is also being gained at Porbandar in the installation and operation of a 6 kW Wind Electric Generator (220 volts DC) presented to the CSIR by the West German Government (Fig. 1). It is hoped that before

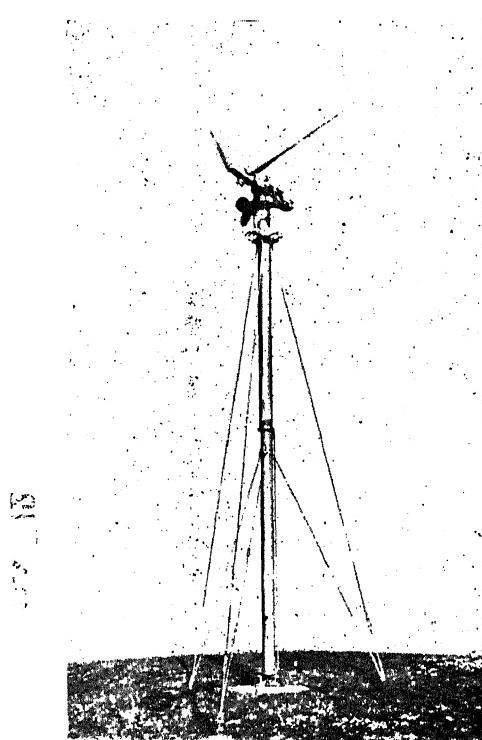


FIG. 1. 6 kW Allgaier wind electric generator with three blades, each 5 metres long.

long similar types of Wind Electric Generators will be designed and constructed by the Laboratory from indigenous materials.

There is no doubt that the Windmill directly pumping water and the small- or medium-sized wind electric generators will be of great use to the large number of villages and for minor irrigation purposes in large tracts of India where there is strong wind, either during most of the year, or at least during those summer months preceding the monsoon when water is most needed.

SYMPOSIUM ON EXPLOSIVES

A THREE-DAY Symposium on 'Explosives' organised jointly by the Explosives Research Development Laboratory, the Institute of Armament Studies, and the Armament Research and Development Establishment, Kirkee, was held on the 15th, 16th and 17th December 1960 at Kirkee.

Fifty-one papers presented at the Symposium were discussed in the three technical sessions. On the first day under the Chairmanship of Dr. R. S. Varma, Director, Defence Science Laboratory, New Delhi, sixteen papers covering the theory, characteristics and applications of propellants were presented and discussed. Dr. A. L. Lovecy of the Ministry of Aviation, U.K., presented an interesting paper on 'Solid Propellant for Rockets'. He gave an outline of research, development and production facilities employed, and discussed the considerations which govern the choice of propellants for evaluation in certain applications. Colloidal (extruded and cast) plastic, elastic and pressed propellants were included in the review providing an impression of their potentialities for current and future designs.

Seventeen papers dealing with Explosives, Primary Explosives and Pyrotechnics were discussed on the second day under the Chairmanship of Dr. H. R. Ambler, Scientific Adviser to the High Commission for U.K. in India. The paper on 'Detonation in Solid Explosives' by Dr. W. M. Evans of the War Office, U.K., evoked considerable interest. Dr. Evans pointed out that detonation processes can in general be observed and measured by optical and by probe techniques because of their highly luminous and ionised nature. With added refinements, associated

processes such as the propagation of shock waves in various inert materials, the projection of scabs or of fragments, can be similarly observed. Flash X-ray techniques are of additional value over the whole field of investigation. Particular mention was made of the techniques used in measuring some of the characteristics of propagation of shock waves in metals and non-metals.

The discussions on the third day mainly consisted of instrumentation and analysis applied to testing of explosives and a few ancillary explosives. Dr. S. K. K. Jatkar, Professor of Chemistry, Poona University, was in the chair and eighteen papers were presented. Dr. H. R. Ambler in his paper on 'Some New Analytical Methods applicable to Explosives' discussed the possibility of using special methods of instrumental analysis such as gas chromatography, chromato-polarography, paper electrophoresis, ultra-violet spectroscopy, thermogravimetry, differential thermal analysis, microscopic chemistry, and the Weisz ring oven in the testing of explosives and explosive products.

Dr. Evans read a paper on "Testing of Equipment for Proper Functioning and Safety in Hot Climates". There was also an interesting discussion on the manufacture of Guanidine nitrate by the 'Ammonium Nitrate Urea' process.

There were two evening lectures : (1) "The Manufacture, Storage and Use of Commercial Blasting Explosives" by Dr. J. C. Hornel, Managing Director, Imperial Chemical Industries (I) Ltd, and (2) "On Organisation of Research for Defence" by Maj. Gen. B. D. Kapur, Chief Controller of Research and Development, New Delhi.

NEW ZEISS INSTRUMENTS AT THE 1961 TECHNICAL FAIR IN LEIPZIG

As in previous years there will be exhibited this year also at the Technical Fair in Leipzig, on the Zeiss Stand in Hall XV and in the adjoining Zeiss pavilion, a wide range of VEB Carl Zeiss JENA instruments embodying the latest improvements and designs. Many of these instruments will be on show for the first time.

The Sonovisor 2 (Fig. 1) is an ultrasonic material inspection instrument for the non-destructive testing of metals, porcelain and plastics with regard to cracks, blowholes, pitting or structural changes. The special advantage of this instrument, based on the principle of

the pulse-echo method, is the two-dimensional image presentation by means of the rotary section and vibration section method. The versatile instrument acts as a sort of depth magnifying lens. On correctly setting the brightness and definition of the electron beam, the instrument produces an extremely clear image. Amplification and pulse width can be controlled manually so as to produce the toothed or section image required for testing.

Three new items are introduced in the field of Zeiss Surveying Instruments : (a) The Theodolite 120 is intended for work of lower accuracy in a wide variety of fields such as

forestry, structural and mining surveying, simple geographical, geological and geophysical tasks; (b) The Reducing Telemeter 036 designed especially for detail surveys with cadastral accuracy will be suitable for such tasks as polar detail surveys, angle measuring of polygonal traverses, architectural surveys,

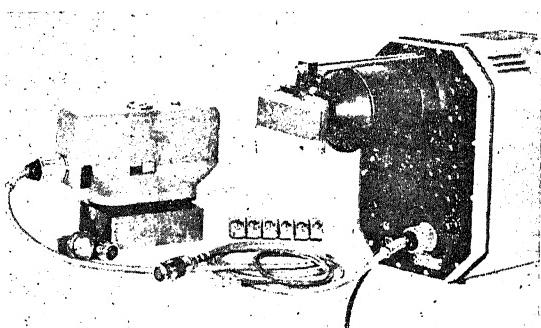


FIG. 1. Instrument for the non-destructive ultrasonic material testing.

civil engineering works; (c) A Meridian Finder (Fig. 2) has been developed for the Theodolite 020, permitting the determination of the astronomical azimuth of a terrestrial target with an average error of approximately ± 1 .

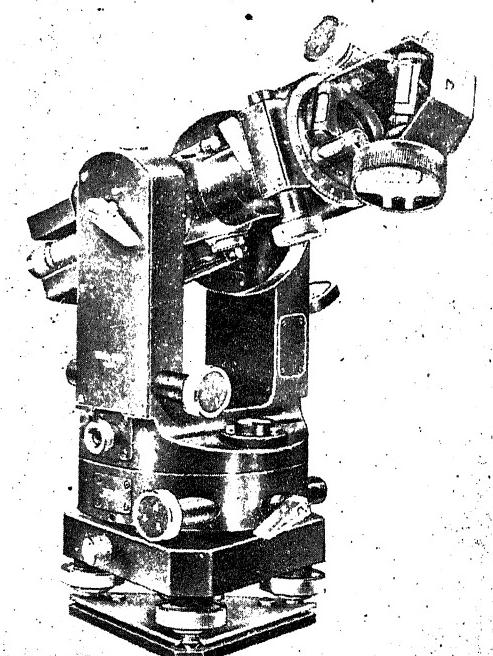


FIG. 2. Tacheometer theodolite "Theo 020" with Meridian Finder.

The range of photogrammetric evaluation instruments of VEB Carl Zeiss JENA has been extended by two new instruments. (a) The Stereometrograph a two-image evaluating instrument for graphical and numerical individual model evaluation of standard and wide angle vertical exposures, (b) The Zeiss Co-ordimeter a programme controlled recording and calculating machine for photogrammetric evaluating instrument, carrying out automatic recording of machine co-ordinates as well as programme-controlled calculations.

Of the new medical instruments, the following deserve special mention: (i) The Electrocymograph an instrument for recording the progression of heart wall movements or lung pulsations during irradiation of the patient with X-rays. (ii) The Separating Chamber for Paper Electrophoresis (Fig. 3) serves for electrophoretic

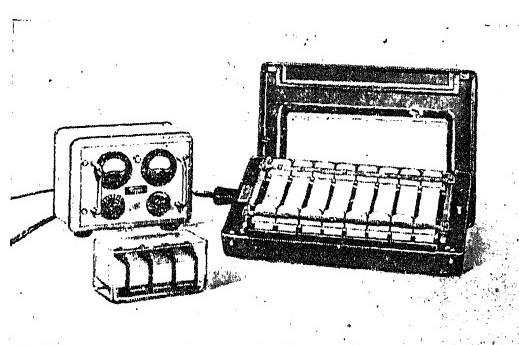


FIG. 3. Separating cell for paper electrophoresis.

separation of colloidal solutions (blood serum) on filter-paper and ensures by uniform test results the reproducibility of the separation tests, and (iii) The Surgical Microscope II which is a stereoscopic surgical microscope for universal application in nose, throat and ear surgery.

The Astro-Division of VEB Carl Zeiss JENA which attained world-wide success by building the 2 m-Universal Reflecting Telescope for the Karl Schwarzschild Observatory, in Tautenburg, introduced two new small astronomical instruments: a powerful astronomical telescope for schools and amateurs with a semi-apochromatic lens AS of 63 mm. internal aperture and 840 mm. focal length, and the Meniscas 150/900/2250 a cassegrain reflecting telescope with a miniscus-shaped entrance lens with polished Cassegrain mirror whose high image quality permits in addition to visual observation, photographs of celestial objects and close subjects from 30 metres distance upwards.

LETTERS TO THE EDITOR

EFFECT OF ELECTRICAL OSCILLATIONS ON THE ELECTRIC FIELD IN THE CATHODE DARK SPACE OF A COLD CATHODE GLOW DISCHARGE

DURING the course of the investigation on the space distribution of the potential in the discharge region of a cold cathode glow discharge, by the electron beam method, it was observed by Warren¹ that the electrical oscillations even when they were present in the plasma region of the discharge, did not have any effect on the field in the cathode dark space.

This interesting result which was observed both for the normal and the abnormal régimes of the discharge can be understood in case of the normal discharge in terms of its voltage-regulating action where an incremental change in the applied voltage V_p does not change the voltage drop V_c across the tube but brings about only a change in the discharge current I , with the result that the incremental voltage is transferred to the load.

As the current density at the cathode also remains constant within the given range of I (in the case of the normal discharge), there would be a corresponding change in the cross-section due to the change in the applied voltage V_p . The A.C. signal voltage due to the electrical oscillations superposed on the D.C., should by this argument give rise to a corresponding A.C. component in the cathode current but not in the total voltage across the discharge tube. The absence of the A.C. component in this voltage would naturally mean that the space potentials at the different points in the cathode dark space will have no A.C. component. This conclusion will require a modification if the voltage-regulating action, which is presumably determined by the space-charge effects in the region of the cathode dark space, shows a dependence on the frequency of the superposed A.C. signal.

In order to confirm this conclusion experimentally a variable frequency A.C. signal of strength 7-10 V. peak-to-peak from an A.F. oscillator was injected using a transformer in the circuit of a V/R 105 (specified current range 5-40 m.a.) with a load of 10 K. ohms. The A.C. potential-drop across the tube was measured with a C.R.O., in the frequency range 100 c/s to 100 kc/s. This range represents

the frequency region in which the electrical oscillations in the glow discharge have been generally observed.^{2,3}

The results which are shown graphically in Figs. 1 and 2 indicate that for frequencies up to

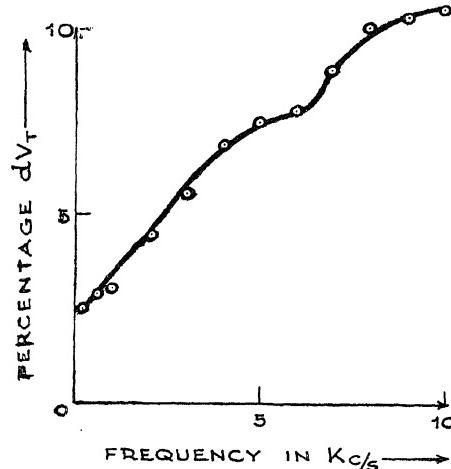


FIG. 1

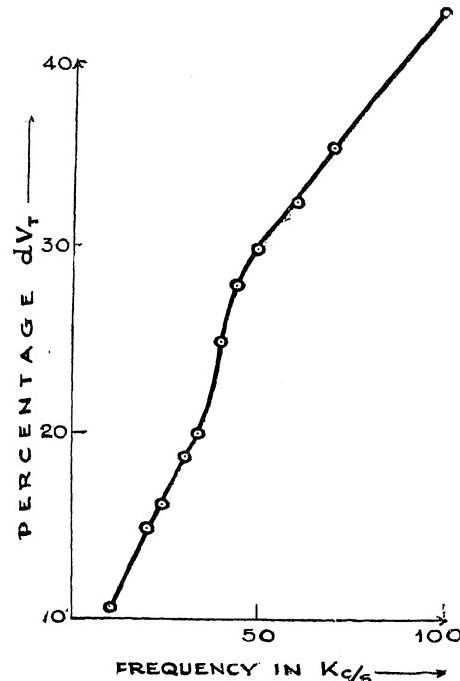


FIG. 2

10 kc, less than about 10% of the input signal appears across the discharge tube. The percentage increases continuously to about 40% at $f = 100$ kc. The results therefore support the explanation proposed for the observation of Warren.

Physics Department, V. T. CHIPLONKAR.
Institute of Science, S. S. MANECK.
Mayo Road, Bombay, January 12, 1961.

1. Warren, R., *Phys. Rev.*, 1955, **98**, 1650.
2. Donahue, T. and Dieke, G., *Ibid.*, 1951, **81**, 248.
3. Chiplonkar, V. T. and Mangaly, J., *Proc. Ind. Acad. Sci.*, 1959, **49**, 202.

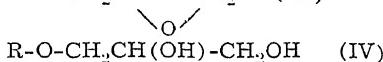
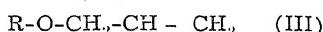
REACTIONS OF EPICHLOROHYDRIN WITH PHENOLS

In continuation of our previous work¹ on the reactions of epichlorohydrin (I) with amines, we wish to report the results of the condensation of (I) with phenols. Although some work has appeared on this subject,² our results are of interest, since the condensation leads to products similar to Mephenisin, which has muscle-relaxing properties.

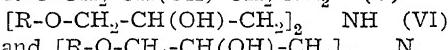
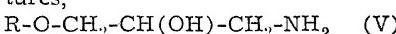
The reaction of (I) with *o*-, *m*-, and *p*-cresols, *p*-chloro and *p*-nitrophenols, and 3 : 5-xylen-1-ol, in the presence of piperidine hydrochloride gave compounds of the following general formula



By refluxing these compounds over powdered potassium hydroxide in ether solution, the corresponding epoxy compounds were obtained. These epoxy compounds on treatment with dilute sulphuric acid yielded the corresponding diols (IV).



The hydroxychloro (II) as well as epoxy (III) compounds on reaction with ammonia gave rise to a mixture of primary, secondary and tertiary bases having the following structures,



and $[\text{R}-\text{O}-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2]_3 \text{ N}$.

The compounds prepared are listed in Tables I and II.

TABLE I

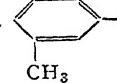
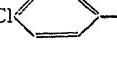
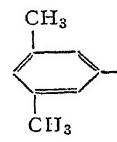
No.	Compound R =	b.p./pr	b.p./pr	R-O-CH ₂ -CH(OH)-CH ₂ Cl		R-O-CH ₂ -CH(OH)-CH ₂ OH	Analysis		Analysis	
				Calcd.	Found		Calcd.	Found	Calcd.	Found
I		190-94°/20 mm.	136-40°/15 mm.	C, 73.2; H, 7.3;	C, 73.6; H, 7.1	71-72°	C, 65.9; H, 7.7;	C, 65.8; H, 7.8		
II		158-70°/20 mm.	130-38°/20 mm.	C, 73.2; H, 7.3;	C, 73.5; H, 7.3	66-67°	C, 65.9; H, 7.7;	C, 65.6; H, 7.8		
III		175-77°/20 mm.	140-42°/15 mm.	C, 73.2; H, 7.3;	C, 73.8; H, 7.5	62-65°	C, 65.9; H, 7.7;	C, 65.5; H, 7.5		
IV		180-84°/20 mm.	146-48°/20 mm.	C, 58.5; H, 4.9;	C, 58.7; H, 4.8	Oil	..	..
V		216-18°/10 mm.	..	..	..	62-64°	C, 53.3; H, 5.4;	C, 53.5; H, 5.3		
VI		138-40°/10 mm.	..	..	..	Oil	..	..

* Analysis : Calcd. for $\text{C}_{11}\text{H}_{15}\text{O}_2\text{Cl}$, C, 61.5; H, 7.0

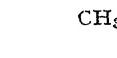
Found C, 61.2; H, 7.3

Compounds I to V in column I are known.

TABLE II

No.	Compound R=	R-O-CH ₂ -CH(OH)-CH ₂ -NH ₂				[R-O-CH ₂ -CH(OH)-CH ₂] ₂ NH			
		Charac- terized as	m.p.	Analysis		Charac- terized as	m.p.	Analysis	
				Calcd.	Found			Calcd.	Found
I	CH ₃ 	Base	103-4°	C, 66.3; H, 8.3; N, 7.7;	C, 66.5; H, 8.1; N, 7.6	Base	108-10°	C, 69.6; H, 7.8; N, 4.1;	C, 70.0; H, 7.8; N, 4.4
II		Base-HCl	Softens at 13° Clears at 256°	N, 6.4;	N, 6.5	do.	116-17°	N, 4.1;	N, 4.3
III		do.	Softens at 126° Clears at 264°	N, 6.4;	N, 6.5	..	..	..	..
IV	Cl 	do.	Softens at 172° Clears at 270°	N, 5.9;	N, 6.1	Base	125-27°	N, 3.6;	N, 3.4
V		do.	Softens at 190° Clears at 270°	N, 6.5;	N, 6.6	Base-HCl	128-29°	N, 3.8;	N, 4.0

[R-O-CH₂-CH(OH)-CH₂]₃N

No.	Compound R=	Characterized as	m.p.	Analysis	
				Calcd.	Found
I	CH ₃ 	Base-HCl	170-71°	C, 66.5; H, 7.3; N, 2.6;	C, 66.4; H, 7.0; N, 2.6
II		do.	134-35°	N, 2.6;	N, 2.8
III		..	..	..	..
IV	Cl 	Base-HCl	Softens at 170° Clears at 261°	N, 2.3;	N, 2.5
V		do.	Softens at >125° Clears at 258°	N, 2.5;	N, 2.8

Institute of Science, J. R. MERCHANT.
 Bombay-1, A. S. U. CHOGHULEY.
 November 23, 1960.

2. Lindemann, *Ber.*, 1891, 24, 2145; Boyd and Knowlton, *J. Chem. Soc.*, 1909, 95, 1802; Boyd and Maile, *J. Chem. Soc.*, 1910, 97, 1788; Marle, *J. Chem. Soc.*, 1912, 101, 305; Levas and Lefabre, *Compt. rend.*, 1946, 22, 555, 1439; Bradley, Forrest and Stephenson, *J. Chem. Soc.*, 1951, 1589; Stephenson, *J. Chem. Soc.*, 1954, 1571.

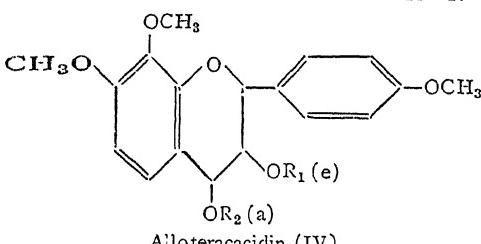
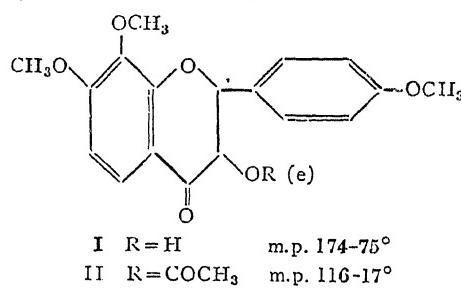
SYNTHESSES OF O-TRIMETHYL ALLOTERACACIDIN AND O-TRIMETHYL ALLOISOTERACACIDIN

CLARK-Lewis and Mortimer¹ recently reported the isolation of new leucoanthocyanidins "Teracacidin" and "Isoteracacidin" from *Acacia intertexta* and have designated them as 7 : 8 : 4'-trihydroxyflavan-3 : 4-diols.² These authors have further shown that teracacidin is stereochemically analogous^{2,3} with melacacidin⁴ ($C_2 : C_3$ -cis, $C_3 : C_4$ -cis) and isoteracacidin is its "4" epimer ($C_2 : C_3$ -cis, $C_3 : C_4$ -trans). The present communication describes the syntheses of their epimers as trimethyl ethers.

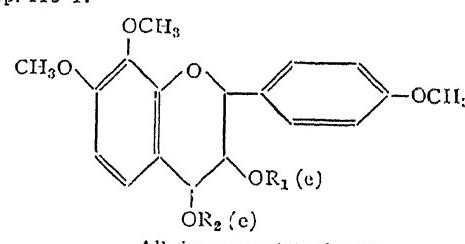
7 : 8 : 4'-Trimethoxydihydroflavonol (I), m.p. 174-75° (Found: C, 65.2; H, 5.3; $C_{18}H_{18}O_6$ requires C, 65.4; H, 5.4%) was prepared by cyclisation of the corresponding acetoxy-chalkonedibromide by Rasada reaction.⁵ The dihydroflavonol (I) was characterised by preparation of its acetate (II), m.p. 116-17° (Found: C, 64.8; H, 5.3; $C_{20}H_{20}O_7$ requires C, 64.5; H, 5.4%). Hydrogenation of the dihydroflavonol acetate over Raney nickel furnished 7 : 8 : 4'-trimethoxy-3-acetoxyflavan-4-ol (III), m.p. 149-50° (Found: C, 64.3; H, 5.9; $C_{20}H_{22}O_7$ requires C, 64.2; H, 5.9%). 7 : 8 : 4'-

121-22° (Found: C, 63.6; H, 5.9; $C_{22}H_{22}O_8$ requires C, 63.5; H, 5.8%), which was identical with the one obtained on acetylation of the diol (IV). The dibenzoate (IV), m.p. 151-52° (Found: C, 70.8; H, 5.2; $C_{32}H_{28}O_8$ requires C, 71.1; H, 5.2%), of the diol (IV) was prepared for comparison with the dibenzoate of the other diol. 7 : 8 : 4'-Trimethoxydihydroflavonol (I) on reduction with lithium aluminium hydride gave a mixture of flavan-3 : 4-diols isomeric in position "4". The mixture had melting range 85-100° and was extremely difficult to separate. However on repeated crystallisations another diol (VII), m.p. 155-56° (Found: C, 65.4; H, 5.9; $C_{18}H_{20}O_6$ requires C, 65.1; H, 6.0%), was obtained in poor yield together with the diol (IV). The diol (VII), m.p. 155-56°, was characterised by preparing its dibenzoate (VIII), m.p. 175-76° (Found: C, 71.4; H, 5.5; $C_{32}H_{28}O_8$ requires C, 71.1; H, 5.1%). Both the diols (IV) and (VII) gave violet colour with concentrated sulphuric acid and pink colour,⁶⁻⁹ characteristic of anthocyanidin formation, on warming with alcoholic hydrochloric acid.

On the basis of postulates of Joshi and Kulkarni¹⁰ 7 : 8 : 4'-trimethoxyflavan-3 : 4-diols



IV	R ₁ = R ₂ = H	m.p. 125-26°
III	R ₁ = COCH ₃ , R ₂ = H	m.p. 149-50°
V	R ₁ = R ₂ = COC ₆ H ₅	m.p. 121-22°
VI	R ₁ = R ₂ = COC ₆ H ₅	m.p. 151-52°



VII	R ₁ = R ₂ = H	m.p. 155-56°
VIII	R ₁ = R ₂ = COC ₆ H ₅	m.p. 175-76°

Trimethoxy-3-acetoxyflavan-4-ol on hydrolysis gave 7 : 8 : 4'-Trimethoxyflavan-3 : 4 diol (IV), m.p. 125-26° (Found: C, 65.4; H, 6.4; $C_{18}H_{20}O_6$ requires C, 65.1; H, 6.0%). 7 : 8 : 4'-Trimethoxy-3-acetoxyflavan-4-ol on acetylation gave the diol diacetate (V), m.p.

(IV) m.p. 125-26° and (VII) m.p. 155-56° have been assigned 2 : 3-trans-3 : 4-cis and 2 : 3-trans-3 : 4-trans configurations respectively and have been designated as "Alloteteracacidin" and "Alloisoteracacidin".

Chemistry Department,
Institute of Science,
Bombay-1, December 5, 1960.

1. Clark-Lewis, J. W. and Mortimer, P. I., *J. Chem. Soc.*, 1960, 4106.
2. —, Katekar, G. F., *Proc. Chem. Soc.*, 1960, 345.
3. —, Mortimer, P. I. and Katekar, G. F., *J. Chem. Soc.* (Under publication).
4. King, F. E. and Clark-Lewis, J. W., *Chem. and Ind.*, 1954, 757; *J. Chem. Soc.*, 1955, 3384.
5. Limaye, S. D., *Rasayanam*, 1952, 2, 51.
6. King, F. E. and Bottomley, W., *Chem. and Ind.*, 1955, 1062.
7. Bauer, L., Birch, A. J. and Hillis, W. E., *Ibid.*, 1953, 1368.
8. Robinson, G. M. and Robinson, R., *Biochem. J.*, 1933, 27, 206.
9. Bate-Smith, E. C. and Swain, T., *Chem. and Ind.*, 1953, 377.
10. Joshi, C. G. and Kulkarni, A. B., *Ibid.*, 1954, 1456; *J. Ind. Chem. Soc.*, 1957, 34, 753.

THE UPTAKE AND REDUCTION OF BROMATE BY WHEAT-ROOTS

WITHIN the framework of our research programme the uptake, metabolism and the effect of the different haloid and halogenate ions on higher plants are being systematically studied. Investigations are being made with the object of comparing the special characteristics of their uptake on the one hand, and, on the other hand, we aim at clarifying the mechanism of their toxicity. With regard to the bromate, Aberg¹ pointed out that the toxicity stems from the reductions of bromate taking place in the plants. As far as we know no one has made use of the possibility afforded by radioactive isotopes to study this reduction of bromate, apart from the determination of the transformation taking place in the baking of bread.⁴

In order to investigate bromate uptake and reduction we used Br⁸² isotope which had been obtained through the Isotope-Distribution Institute of the National Atomic Energy Commission from the reactor of the Central Physical Research Institute in the form of KBr solution. At the time of delivery the activity of the solution was 1.66 mC./ml., containing 2.5 mg. KBr per millilitre. There was no radioactive contamination to be detected in the solution, but a considerable amount of Br⁸⁰ was found at this stage. The latter, because of its shorter half-life, decayed before the experiments.

The electrolytic oxygenation method described by Lee *et al.*⁴ was employed to produce bromate. A micro test-tube was used to function as the electrolytic cell in which two platinum plate-electrodes had been placed with a distance of

about 3 mm. between them. 250 mg. KBr, 0.4 ml. of 0.1 N HBr and 0.2 ml. of 1% K₂Cr₂O₇ solutions were added to 1 ml. of radioactive solution and the electrolysis was made with about 2.3 volts at 60 mA for 12 hours. For reasons of safety the apparatus had been placed inside a series of gas wash-bottles which were aerated, but this proved to be unnecessary since no radioactive gas developed.

The crystals formed were purified by means of recrystallization until the colour of the bichromate was no longer evident. At the end of the process 140 mg. KBr⁸²O₃ was obtained from which solutions were made with a concentration of 1 ml. equiv./l. to be used in the experiments.

Each experiment lasted for 6 hours and was made with excised wheat-roots and the method adopted was similar to the one described when studying iodate reduction.³ There was an alteration in the method of extraction of the radioactivity taken up. Based on some of our earlier experiments we came to the conclusion that Br⁸² could more easily be extracted from plants than I¹³¹ and that practically there was no detectable activity to be found after the alcoholic-distilled water extraction. So the residue was not investigated in these experiments.

Samples were made from aliquots of the alcoholic-water extract and their activity was measured by means of an 1.3 mg./cm.² end-window GM-tube, and from another part chromatograms were made in the same way as has been described in our earlier papers^{2,3} and autoradiograms were taken from these. The distribution of the activity on the chromatogram strips was also determined with an 1.5 mg./cm.² end-window GM-tube by using 1 cm. diaphragm.

The activities measured were compared with those made from the original KBr and KBrO₃ solutions and both of these were measured simultaneously.

The variants used in the experiments were as follows: (1) 1 m. equiv./l. KBrO₃; (2) 1 m. equiv./l. KBrO₃ + 10⁻³ Na-azide; (3) 1 m. equiv./l. KBrO₃ + 50 m. equiv./l. KNO₃; (4) 1 m. equiv./l. KBrO₃ with roots killed by boiling; and (5) 1 m. equiv./l. KBr.

The uptake of the bromate is lower than that of the bromide, but the rate of uptake is comparable. It should be noted that in wheat-roots the bromide has the higher rate of uptake of all halide ions. Attention should be paid to the extent to which the Na-azide inhibits, surpassing the azide inhibition detected in iodate

TABLE I

Bromate and bromide uptake by wheat roots

Variant	Uptake in μ equiv.	Uptake as % of control
1. KBrO_3	..	0.70
2. $\text{KBrO}_3 + \text{Na-azide}$..	0.047
3. $\text{KBrO}_3 + \text{KNO}_3$..	0.47
4. KBrO_3 with roots boiled	..	0.16
5. KBr	..	1.21

uptake.³ Meanwhile the inhibitive effect of the nitrate is lower than in the case of the iodate. Boiled roots seem to have "absorbed" a certain quantity of radioactivity as was seen in the iodate experiments too. As expected this "absorption" is lower. The autoradiogram of the chromatogram and the GM-tube measurements indicate that a large proportion of the bromate taken up transforms into bromide (Fig. 1). The reduction is equal to about 75% of the absorbed quantity. The chromatograms have failed to point to the formation of organic compounds in the plants either from the bromide or bromate. For the sake of comparison the chromatogram strips made from the original bromide and bromate solutions are given in Fig. 1. It is worth mentioning that no detect-

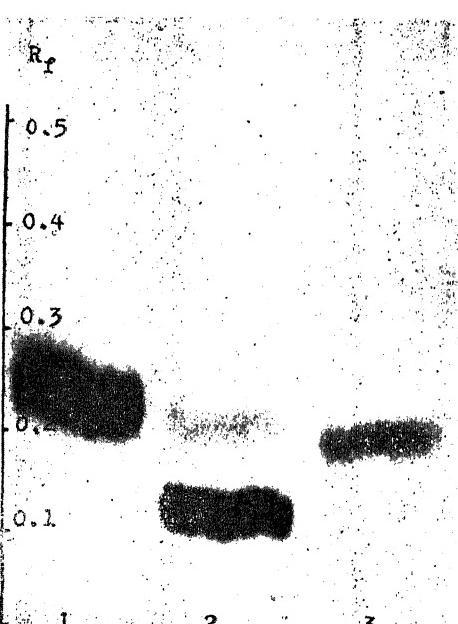


FIG. 1. The radioautogram of the chromatogram, (1) and (2) bromide and bromate outer solutions and (3) the extract of roots after uptake of bromate.

able change was to be found in the composition of the outer solution during the 6-hour experi-

ments. It can be concluded that the bromate, as well as the iodate, is reduced in the roots of higher plants, but unlike the iodate the reduction does not lead to the formation of organic Br-compounds.

Inst. of Plant Physiology

and Central Biological
Isotope Laboratory,

Eötvös University,
Budapest, February 20, 1961.

Z. BOSZORMENYI.

EDITH CSEH.
B. JAMDOR.

1. Aberg, B., *Roy. Agr. Coll. Sweden*, 1948, **15**, 38.
2. Böszörmenyi, Z. and Cseh, E., *Naturwiss.*, 1959, **46**, 584.
3. — and —, *Curr. Sci.*, 1960, **29**, 340.
4. Lee, C. C., Tkachuk, R. and Finlayson, A. J., *Cereal Chem.*, 1958, **35**, 337.

FINGER-TIP PATTERNS OF THE CAR NICOBARESE

THE present note gives a short account of the dermatoglyphics of the fingers of the Car Nicobarese, a Mongoloid people, and inhabitant of Car Nicobar. This island, which belongs to the Nicobar group of islands, is situated between 93° longitude East and 9° latitude North.

No data on dermatoglyphics of this particular people have hitherto been published. Out of 130 finger-prints from male individuals, 128 prints are available for classification of pattern types. The rest two prints could not be deciphered for their incomplete impressions. Arch-loop-whorl classification of Galton has been followed and the results are listed in Table I.

TABLE I

Percentile frequencies of pattern types in 128 digits

	Hands	Whorls	Ulnar loops	Radial loops	Arches
R	.. 36 (57.14)	26 (41.27)	1 (1.59)	..	
L	.. 33 (50.77)	30 (46.15)	2 (3.08)	..	
Both	.. 69 (53.91)	56 (43.75)	3 (2.34)	..	

Table I shows that the arch is completely absent in the Car Nicobarese. Most probably the lacking of this pattern type is due to chance or due to the small size of the sample, as arches compared with other apical patterns occur very less (0.8 to 3.0%) in different Mongoloid peoples.

The author expresses his thanks to Shri N. Shyam Choudhury, Anthropologist, who collected these prints and to Dr. A. K. Mitra, the then Deputy Director, Department of

Anthropology, Government of India, who made them available to the author for analysis.

Dept. of Anthropology, P. N. BHATTACHARJEE,
Govt. of India, Indian Museum,
Calcutta-13.

December 23, 1960.

**A NEW RECORD OF THE ANCHOVY
THRISSOCLES VITIROSTRIS
GILCHRIST AND THOMPSON FROM
INDIAN WATERS***

Of the fourteen described species of the anchovy, *Thrissocles* Jordan & Evermann, twelve have so far been recorded from Indian waters (Misra¹). Of these, *T. mystax* Schneider, *T. dussumieri* Cuv. & Val., *T. setirostris* Broussonet, *T. malabaricus* Bloch, and *T. hamiltonii* Gray have been identified off Waltair coast. The last two are comparatively rare. A careful examination of the meristic characters of the local anchovies has revealed that a sixth species, *T. vitirostris* Gilchrist & Thompson (Fowler²), previously reported only from southern African waters, also occurs locally.

T. vitirostris G. & T. closely resembles *T. mystax* Schn., and in fact could be mistaken for the latter: in both species the maxillary extends to a little beyond the base of the pectoral fin, and many of their body proportions overlap. *T. vitirostris* however can be easily identified by opening the gape of the mouth wide—the gill arches are bright orange-coloured, and the relatively large number of gill-rakers (*vide* below) is immediately noticeable.

The distinguishing characters of *T. vitirostris* G. & T. are: Height (Depth) $3\frac{3}{5}$ - $3\frac{4}{5}$; Head $3\frac{4}{5}$ - $4\frac{1}{10}$; Snout in Head $4\frac{3}{5}$ - $5\frac{1}{10}$; Eye in Head $\frac{4}{5}$ -4. Eye greater than snout.

The range in the meristic characters of *T. mystax* Schn. and *T. vitirostris* G. & T. from Waltair is given below:

	<i>T. mystax</i> <i>n</i> =98	<i>T. vitirostris</i> <i>n</i> =25
Ventral scutes	16-18+9-11	16-18+10-12
Dorsal ..	14-16 M=14.05	13 15 M=14.00
Anal ..	75-10	75-40
Pectoral ..	11-14 M=12.56	12/17-18=12.40
Gill-rakers	9-1+14-17	15-17+10-23
Vertebrae	44-46 M=45.01	45/46 M=45.06

The difference in the number of gill-rakers is significant; further, although the gill-arches are orange-coloured in both species, the colour is deeper and more bright in *T. vitirostris*.

There is also a significant difference in the means of the dorsal fin rays.

This is the first record of *T. vitirostris* G. & T. from Indian waters. Smith³ considers this species as a synonym of *T. malabaricus* Bl., and described it under the latter name, but the description and figure given by him indicate that the species recorded by him is not *T. malabaricus* Bl. [because the latter species is much broader (Fowler, *op. cit.*), and the maxillary hardly extends beyond the opercular opening, whereas he clearly states that the "maxilla reaches barely beyond pectoral base"]. The species described by him may be *T. vitirostris* G. & T. because the raker number given by him (21-25) is in general agreement with that given by Fowler (21-24) for the species from the same region, but then he gives the number of anal fin rays as 40-43, whereas Fowler gives it as 38-40, and in the forms from Waltair it ranges between 35 and 40.

Detailed studies on the seasonal distribution, biometry, length frequency and growth rate, and spawning of *Thrissocles* spp. of Waltair coast are in progress, and the results will be published elsewhere.

The author expresses his grateful thanks to Prof. P. N. Ganapati, for valuable suggestions and for kindly going through the manuscript.

Department of Zoology,
Andhra University,
Waltair, December 3, 1960.

S. DUTT.

1. Misra, K. S., *Rec. Ind. Mus.*, 1952, Part 4, 60.
2. Fowler, H. W., *U.S. Nat. Mus. Bull.*, 1941, 13, 100.
3. Smith, J. L. B., *Sea Fish. South Africa*, 1953.

* Since the communication of this note, the author has observed *T. vitirostris* in catches obtained from Kakinada and Mangalore.

EFFECT OF INITIAL MOISTURE CONTENT OF DIFFERENT FOOD MATERIALS ON DEVELOPMENT AND SEX RATIO IN *CORCYRA CEPHALONICA* STAINTON

RAO (1954)¹ studied, among other things, the influence of the quality of larval food on the length of developmental period and on the sex of the emerging moths of *Corcyra cephalonica* Stanton. He also observed the effect of removal of free water from food material on the development of *Corcyra*, but he did not devote attention to a study of the effect of various types of food in which there was a higher moisture content than the normal. The present studies were undertaken to see the effect of higher

moisture content in the food on the developmental period and the sex ratio.

One hundred and fifty grams of broken grains of 'Jowar' (Sorghum), groundnut, cowpea, rice, wheat and maize with 9% and 12% moisture content of each, were separately kept in small glass troughs and six newly hatched first instar larvae of *Corcyra cephalonica* were introduced in each of the above troughs on the same day. There were three replications for each type of moisture content in all the foods. The test insects were bred exclusively in the laboratory from a single pair of *Corcyra* moths. The dates of emergence of the first moth and of the subsequent emergences of moths together with their sexes were recorded. These studies were conducted in the laboratory at an average temperature of $92^{\circ}\text{F.} \pm 5^{\circ}\text{F.}$ with an average relative humidity of 40%. From the observations recorded in Table I, it may be

TABLE I

Development of *Corcyra cephalonica* Stainton in various food materials having different moisture contents

Food materials	Initial moisture content %	*Average life-cycle period in days	*Average percent-age of females
Broken 'jowar' grains	9 approx. 12	50.6 47.0	44.4 61.1
Broken groundnut seeds	9 12	59.0 53.6	27.8 44.4
Broken cow-pea seeds	9 12	64.3 63.0	16.7 22.2
Broken rice (coarse and white)	9 12	48.0 44.6	61.1 61.1
Broken wheat	9 12	52.0 48.0	38.9 44.4
Broken maize seeds	9 12	54.0 50.6	38.9 44.4

* Average of 3 replications.

seen that, on the whole, coarse, white rice was the best food where the minimum time was taken for the development (48.0 days with 9% moisture content and 44.6 days with 12% moisture content on an average) while, in cow-pea, it took the maximum time for the insect to develop (64.3 days with 9% and 63.0 days with 12% moisture content respectively). The higher of the two moisture contents namely, 12%, was found in every case to be the most

conducive to development. The highest average percentage of females (61.1%) was obtained in rice under both moisture contents and the lowest ratio was in cow-pea, namely, 16.7% and 22.2%, respectively, with 9 and 12% moisture contents. It was further observed that an initial moisture content of 12% was, on the whole, favourable for the production of larger number of female moths in all the food materials tried except in the case of coarse rice where the sex ratio of the male and female moths was 50 : 50.

The author is grateful to Dr. E. S. Narayanan, Head of the Division of Entomology, for his interest in this work.

Division of Entomology, SNEHAMOY CHATTERJI,
Indian Agricultural
Research Institute,
New Delhi-12, June 23, 1960.

1. Rao, D. S., "Notes on the rice moth, *Corcyra cephalonica* Stainton (Galleriidae: Lepidoptera)," *Indian J. Ent.* 1954, 16(2), 95-114.

STUDIES ON THE TRANSLOCATION OF RADIOACTIVE SCHRADAN IN PLANTS AND ITS UPTAKE FROM FILM BY INSECTS

OCTAMETHYL pyrophosphoramide (schradan) has been recognised as a systemic insecticide. Ripper *et al.*¹ and Greenslade² showed that it had a mild contact toxicity also, whereas Duspiva³ indicated that its contact action was quite strong on some sucking insects. In view of its potentialities the present studies were undertaken to examine its systemic as well as its contact action by using P³² labelled schradan. The translocation of schradan was also studied. The study was carried out in two different ways. In the first case, 5 ml. of 0.5% solution of radioactive schradan was mixed with 30 ml. of standard culture solution. The cotton-seedlings were dipped in the radioactive solution thus prepared for periods of 10, 20, 30 and 40 minutes respectively, after which they were transferred to normal culture solutions. In the second case, 100 ml. of 0.25% solution of radioactive schradan was used to irrigate cotton and sugarcane plants grown in earthen pots. It was observed that schradan was translocated to the leaves in cotton-seedlings even with a 10 minutes dip in its solution and stayed there at least for 10 days, for which period the experiment lasted. The radioactivity of the leaf was found to increase for the first four

days, the maximum effect being found on the fourth day, after which it started declining. On the other hand, in the irrigation method it was noted that the rate of translocation of schradan was quicker for the first two days in cotton plants but more or less uniform in sugarcane plants, being maximum on the seventh day in both cotton and sugarcane plants after which it started to decline. It is concluded that radioactive schradan is absorbed by the roots of the plant and is translocated to other parts of the plant, the rate of translocation varying from species to species of plants.

Trials were also made to study the uptake of schradan from film by insects. For this purpose, two series of experiments were laid out. In one set of the first series, 30 nymphs of *Dysdercus koenigii* Fabr. were pretreated at 38° C. for two hours and then released over filter-paper which had been previously soaked in 1 ml. of 0.5% solution of radioactive schradan and dried under an infra-red lamp. The activity of the test insects was assayed after 24 hours. It was observed that all the *Dysdercus* nymphs were dead on the fourth day. In the second set, 40 nymphs of *Dysdercus* were released on filter-papers soaked in the same proportion and concentration as in the first set and then exposed to 38° C. for 20 hours along with the treated filter-papers. It was observed that all the *Dysdercus* nymphs were dead on the second day.

In one of the sets of the second series of experiments, 20 adults of *D. koenigii* were exposed to film of 0.5% solution of schradan and kept at temperatures of 38° C., 35° C. and 30° C. for 24 hours. The treated insects were then kept at room temperature as such. In the other set, 20 adults of *D. koenigii* were exposed to film of 0.5% solution of radioactive schradan and kept at temperatures of 30°, 25°, 20° and 15° C. for 24 hours. The test insects were then removed to clean containers and kept at the above temperatures. The observations confirmed that schradan, though a systemic insecticide, was also picked up by the insects from film in considerable quantities. Both the dead and living insects were assayed, as a result of which the pick-up of the insecticide from the film was definitely confirmed. The uptake of the insecticide also apparently increased with the rise in temperature.

The authors wish to express their gratitude to Dr. S. Pradhan, Professor of Entomology, for supervision and helpful suggestions,

Division of Entomology, SNEHAMOY CHATTERJI,
Indian Agricultural Research Institute, G. W. RAHALKAR.
New Delhi-12, G. R. SETHI.
June 23, 1960. P. N. SAXENA.

1. Ripper, W. E. et al., *Bull. Ent. Res.*, 1950, 40, 481.
2. Greenslade, R. M., *Proc. 2nd Internat. Congr. Crop. Prot.* 1949, 1951, 158.
3. Duspiva, F., *Mitt. Biol. Zentralanst. Lind. Fort. wirtsch.*, 1951, 70, 91.

A SINGLE VALUE MEASURE FOR SOIL TEXTURE

MANY physical properties of soil are often expressed by single value constants. As most of these properties are ultimately related to the colloidal content, these numerical values may be taken as indexes of the texture of the soil. There is, however, no suitable constant for directly expressing the soil texture. Summation curve gives an idea of the mechanical composition but it does not indicate by a single numerical figure the exact textural class of the soil.

Whittles (private communication) has recently suggested a simple method of expressing the soil texture by a single value "y". It is calculated by first drawing the summation curve of the soil from the values of individual fractions raised arithmetically so that they total 100, expressing the area lying below the curve as a percentage 'a' of the total area of the rectangle and then calculating the value 'y' as

$y = \log c + \log (c-a) - \log (100-c)$

where c is the arithmetically raised percentage of the clay on the international system. A higher value of "y" indicates a heavy soil with high clay content, and a lower value shows a light soil in which sand fraction predominates.

The validity of this was tested on a large number of Indian soils of different classes, with wide variation of texture. The different textural classes of these soils according to the triangular diagram of Prescott and their corresponding "y" value limits found, are given in Table I.

TABLE I

Textural classes of soils	'y' value
Sand	.. up to 0.08
Loamy sand	.. 0.18-0.62
Sandy loam	.. 0.47-0.96
Loam	.. 0.63-0.98
Silty loam	.. 0.81-1.17
Clay loam	.. 0.95-1.25
Silty clay loam	.. 1.25-1.44
Clay	.. 1.04-1.72

Although the "y" value overlaps in some cases, on the whole it gives a fair expression of the soil texture.

I.A.R.I.,
All-India Soil & Land Use Survey,
Nagpur, September 24, 1960.

B. B. Roy.

A SERIOUS OUTBREAK OF THE SUGARCANE MITE ON JOWAR

RECENTLY a severe outbreak of the sugarcane mite, *Oligonychus indicus*, occurred in the jowar experimental plots of the Botany Division at the Indian Agricultural Research Institute. The mites multiplied so rapidly that within a very short time they had spread over a large area and even week-old seedlings were heavily attacked. Dwarf exotic varieties appeared to suffer the greatest damage. Some border rows of the exotic hybrid RS 610 had turned reddish-brown as the leaves dried up under heavy attack by this pest. The undersides of the leaves were covered by mites and their webbing with initial attack occurring in spots near the midrib and spreading throughout the length and breadth of the leaf.

Warm dry weather conditions during the first week of September had provided ideal conditions for mites. Heavy monsoon rains had prevented an earlier build-up of this pest. Under optimum conditions, and in the presence of a plentiful supply of host plants, the mite multiplied unchecked, and resulted in a 'biotic explosion'. A close examination of the affected plants revealed the absence of an important biotic factor usually found associated with the mite. The beneficial lady-bird beetle (*Stethorus pauperculus*), which often follows closely the mite and helps to keep this pest in check, was not found in the field. During 1958 and 1959 this predator was observed to effectively control outbreaks of mite attack. This was pointed out recently by one of the authors (Venkatraman¹). The serious outbreak of mites during the present season may be partially attributed to the effects of frequent insecticidal applications on natural parasites and predators.

It is possible that the continued reliance on a complex chemical control programme for a number of years over a large area not only causes an immediate upset of the natural balance but may also result in semi-permanent changes. Insects or mites not ordinarily considered problems could develop into major pests. Thus, consideration should be given to a control programme that harmonizes biological and chemical methods and which attempts to utilize

selective pesticides that are relatively less harmful to biological control agents and tends to reduce insecticidal treatments to the minimum required to control the specific pest.

Indian Agricultural Research Institute,
New Delhi,
September 23, 1960.

T. V. VENKATRAMAN.
C. L. DHAWAN.
K. O. RACHIE.

1. Venkatraman, T. V. and Sharma, G. R., *Curr. Sci.*, 1960, 29, 313.

RECORD OF *HELICOSTYLOM PYRIFORME*, BAINIER ON SUGARCANE IN INDIA

A MUCORACEOUS fungus was isolated from living sugarcane sheath in one of the fields at Udamalpet in November 1958. It grew readily on neutral oat meal agar producing a highly branched mycelium with rhizoids and an abundance of asexual reproductive structures.

The fungus when grown on Czapek-Dox solution with maltose or glucose replacing sucrose develops a deep olive buff mycelium. The substrate mycelium is highly branched and sporangiophores are borne singly arising not only from the points of origin of the rhizoids but elsewhere also. They are up to 2 cm. in length and fertile at the tip as also at a number of points (2-4) along the length where swellings are present at the point of origin of branches. Branches are short, dichotomous, rarely trichotomous. Pedicels arise at the tips of these branches. The nodal swellings are borne generally in a verticillate manner. Pedicels are straight but sharply curved towards the apex so that the sporangiole is reflexed on the pedicel (Fig. 1). The sporangiole is obpyriform, hyaline, smooth-walled with a dome-shaped columella. Sporangioles bear 20 or more spores. They get detached along with the greater part of the pedicels. They have been rarely observed to dehisce by an irregular apical tear. The apical cluster of sporangioles develops first followed by a downward development at intervals. Downwards the arrangement of sporangioles is to a side of the sporangiophore instead of verticillate. The pedicels are 42.0-105.0 μ in length, the sporangioles 15.9 \times 33.6-13.4 \times 22.7 μ in size, and the spores 4.8 \times 5.0-2.4 \times 4.0 μ in size.

In neutral oat meal agar medium the tip of the sporangiophore was always noticed to bear a cluster of pedicels bearing sporangioles. In strongly acidified medium and under certain conditions of starvation of medium, the sporangiophore tip instead of bearing a cluster of

sporangioles ends in a single, large, globose sporangium (Fig. 2). The sporangium in certain cases lacks a columella.

HELICOSTYLM PYRIFORME, BAINIER

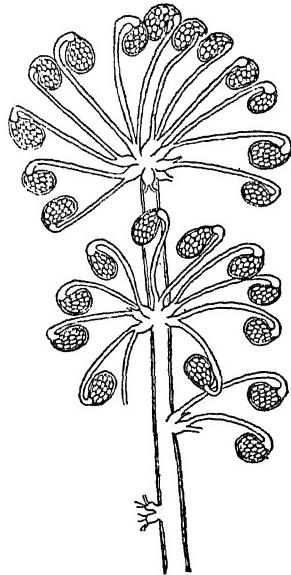


FIG. 1

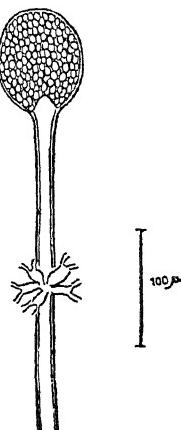


FIG. 2

FIG. 1. Typical sporangiophore with sporangiola.
FIG. 2. Sporangiophore showing single terminal sporangium and verticillate cluster of pedicels below.

Zygospore formation has not been observed.

The fungus has been identified as *Helicostylium pyriforme*, Bainier. This appears to be the first record of its occurrence in India and on sugarcane.

According to the description given by Hesseltine for *Thamnidiaceae*,¹ the terminal sporangium is columellate while sporangiolas are without a well-developed columella. His separation of the genus *Helicostylium* is on the basis of the presence of the terminal sporangium. In the present case the formation of the terminal sporangium appears to occur under special conditions. The occurrence of columella also appears to be a variable character. Hence the usefulness of these characters as taxonomic criteria for separation of the genera in the family, may have to be reconsidered.

Thanks are due to Shri K. V. Srinivasan, Mycologist, Dr. C. V. Subramaniam, Professor of Plant Pathology, Indian Agricultural Research Institute, New Delhi, Dr. C. W. Hesseltine of U.S.D.A. and Dr. J. J. Elphick of C.M.I. for help in identification of the fungus. Thanks

are also due to Dr. J. T. Rao, Botanist, for interest and encouragement.

Sugarcane Breeding Inst., U. VIJAYALAKSHMI, Coimbatore-7, September 28, 1960.

1. Hesseltine, C. W., *Mycologia*, 1955, 47, 334.

DETERMINATION OF TOTAL SOLUBLE SALTS IN THE BLACK CLAYEY SOILS OF ANDHRA PRADESH BY CONDUCTIVITY METHOD

MEASUREMENT of electrical conductivity of soils offers a simple and rapid method for the determination of total soluble salts. The U.S.D.A.¹ has advocated the use of the measurement of electrical conductivity of saturation extracts at 25° C. and then calculating the total soluble salts in soils by using an equation. However, our experience has been that it is difficult to ascertain the precise point of saturation by the criteria prescribed such as glistening of paste as it reflects light, sliding of the paste clearly off the spatula, etc. (*loc. cit.*). According to Reitemier² use of conductivity of soil paste appears to be unreliable due to the factors like variation in saturation percentage, lack of cell constant for cups, etc. For these reasons Piper³ used 1:5 soil-water extract for measuring the electrical conductivity of Australian soils. He suggested the following equation for calculating the total soluble salts from the electrical conductivity of the soils.

$$\text{T.S.S.} = 375 \times \text{EC}$$

where T.S.S. = % total soluble salts in soils, and EC = electrical conductivity in mhos/cm. of 1:5 soil extract at 20° C.

The factor connecting EC with T.S.S. varies from one soil group to another. In the Sudanese soils Joseph and Martin⁴ found the factor to be 250 at 30° C. and 300 at 25° C.

Due to these reasons, the exact relationship between the EC and T.S.S. in the black-clayey tobacco soils of Andhra Pradesh was sought to be determined in the present work.

202 soil samples collected from Ongole and Bapatla Taluks of Guntur District were used in the present study. The EC of 1:5 soil extract was determined using Philips conductivity bridge. The T.S.S. in these soils were determined by the gravimetric method.

It was found that the T.S.S. could be determined by the following equation with a high degree of accuracy.

$$(\%) \text{T.S.S.} = 0.290 \times x + 0.014$$

where, x = electrical conductivity of 1:5 soil extract at 25° C. in millimhos/cm.

The correlation coefficient between the total

soluble salts and conductivity was 0.89 and it was highly significant.

The authors are thankful to Dr. G. S. Murty, Director, for his keen interest and to Sri. M. V. Pavate, Statistician, for working out the statistical correlations.

B. V. KAMESWARA RAO.
A. S. SASTRY.

Central Tobacco Research Inst.,
Rajahmundry, October 7, 1960.

1. *Handbook of United States Department of Agriculture*, No. 60, 1954.
2. Reitemier, R. F. and Wilcox, L. V., *Soil Science*, 1946 **61**, 291.
3. Piper, C. S., *Soil and Plant Analysis*, 1950.
4. Joseph and Martin, quoted in (3).

MULTIPLE ALLELISM FOR PETAL COLOUR IN *LINUM GRANDIFLORUM* DESF.

Linum grandiflorum Desf. is an ornamental plant. The varieties popular with the floriculturists possess flowers with different shades of red colour. These are var. *rubrum* with bright red flowers, var. *kermesinum* with crimson flowers and var. *coccineum* with scarlet flowers (Bailey, 1929). At this Division, a seed sample received from the Economic Botanist (Oilseeds), Kanpur, U.P., was found to give plants with red, pink and white flowers. Pure breeding red and white types were isolated from this material and the pinks invariably segregated for the three floral types in their progeny. At Nilokheri (Punjab), a solitary off-type plant, in a bed of over 2,000 plants of red flowered type, was observed by one of us (P. L. G.) to possess orange flowers, a colour hitherto not reported in the species. Red, orange and white types were intercrossed to study the mode of inheritance of flower colour. Maintenance of parental types, as also the rearing of F_2 's, was done by sibbing owing to limitations imposed by self-incompatibility associated with heterostyly in the species (Lewis, 1943). The genetic data are tabulated in Table I.

TABLE I

Cross	F_1	F_2	χ^2		P
			1 : 2 : 1	or 3 : 1	
Red x White ..	Pink	45 red 86 pink 33 white =164	2.1402	0.30-0.50	
Red x Orange	Red	225 red 75 orange =300	0.0	1.0	
White x Orange	Pink	Has not been studied so far	..	..

It will be seen that red is partially dominant over white and fully dominant over orange. Orange is probably partially dominant over white. The crosses red \times white and red \times orange show monogenic segregation. It appears, therefore, that the same locus is involved in the development of the three petal colours—red, orange and white—in this species.

Division of Botany, A. B. JOSHI.
Indian Agricultural Research M. W. HARDAS.
Institute, New Delhi, P. L. GUGLANI.
October, 6, 1960.

1. Bailey, L. H., *The Standard Encyclopedia of Horticulture*, The Macmillan Co. of Canada, Ltd., Toronto, 1929, 2.
2. Lewis, D., *Ann. Bot. N.S.*, 1943, 7, 115.

NEW HOST PLANTS OF THE TOP-SHOOT BORER OF MAIZE (*CHILO ZONELLUS* SWIN.)

THE top-shoot borer, *Chilo zonellus*, Swinhoe (Pyralidae; Lepidoptera), is known to be a serious pest of maize, jowar and sugarcane. Fletcher and Ghosh¹ have reported that this borer also attacks bajra (*Pennisetum typhoides*), rice, *manduwa* (*Eleusine coracana*), Sudan grass (*Sorghum vulgare* var. *sudanense*) and Job's-tears (*Coix lachryma-jobi*). Trehan and Butani² pointed out two additional host plants of this pest, namely, Johnson grass (*Sorghum halepense*) and Burgur (*Polytoca barbata*). Up-to-date eleven different host plants have been recorded. The pest appears to have a wide host range and a review of literature indicates that it has so far been reported to occur only on monocotyledonous plants.

During the 1960 kharif season, an experiment was laid out at the Indian Agricultural Research Institute, to study the comparative damage caused by *Chilo zonellus* at different dates of planting and to study resistance of inbred lines of maize to the pest.

A careful study of the weeds growing around these plants and in the field revealed the presence of egg masses of *Chilo zonellus* on their leaves. The weeds showing the egg masses were *Eragrostis* sp. and *Eleusine verticillata* (both monocotyledonous weeds) and *Trianthema monogyna* (a dicotyledonous weed).

The egg masses were collected from the weeds and were studied along with the larvæ that hatched from them. They were found to be those of *Chilo zonellus*. Maize plants were then inoculated with these larvæ and the characteristic dead-heart symptoms were

recorded. This observation further confirmed that the larvæ were those of *Chilo zonellus*.

It, therefore, appears that *Chilo zonellus* has a wider host range, embracing even the dicotyledonous plants. The present record constitutes the first report on a dicotyledonous plant being a host of this pest. The observations reported here provide evidence to the effect that a certain amount of infestation in maize plants in the fields can take place via the egg masses and larvæ of *Chilo zonellus* present on the weeds mentioned above. It may be added that the three weeds, namely, *Eragrostis* sp., *Eleusine verticillata* and *Trianthema monogyna*, occur widely in the maize fields in the north-western plains of India.

Division of Botany,
Ind. Agri. Res. Inst.,
New Delhi-12,
October 24, 1960.

JOGINDER SINGH.
N. L. DHAWAN.
A. B. JOSHI.

1. Fletcher, T. B. and Ghosh, C. C., *Proc. Third ent. Meeting*, Fusa, 1920 (1), 354.
2. Trehan, K. W. and Butani, D. K., *Indian J. Ent.*, 1949, **11** (1), 47.

SPHAEROPSIS KNOTS ON LIME (CITRUS MEDICA VAR. ACIDA LINN.) IN RAJASTHAN

DURING the month of February, 1960, a few lime (*C. medica* var. *acida* Linn.) plants in an orchard in Ajitgarh (Rajasthan) were found to have developed knots on certain branches which gave witches' brooms appearance (Fig. 1). Such knots have been attributed to the fungus *Sphaeropsis tumefaciens* by Hedges (1911), who reported this disease first on lime trees from Jamaica. Later on, the disease was also recorded from Egypt, British Guiana, Peru, Dominica and the Hawaiian Islands. Since it does not seem to have been reported from any part of India, an annotated account of the symptoms and the fungus associated with it, is presented in this paper.

In early stages, the disease is manifested by the occurrence of hard woody, rounded or irregularly shaped knots on the branches, attached by a broader base, girdling them. They vary in size from a pea grain to 2-3 inches in diameter (Fig. 2). The young ones are covered by smooth green bark. In later stages, they enlarge resulting in the splitting of the bark and become light brown in colour, deeply furrowed and rough. The bark is killed ultimately and the discolouration of wood also takes place to some depth. The knot when cut into two is found to be of hard, compact woody

tissue. Where the disease had well advanced, the branches gave the appearance of witches' brooms, bearing very few leaves and no fruits.

The fungus within the host was traced in the form of branching septate mycelium, consisting

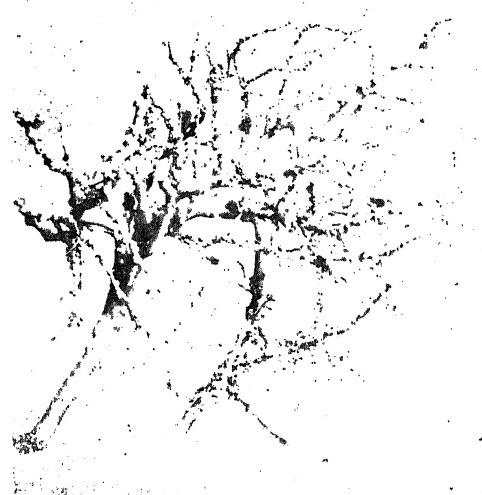


FIG. 1. Witches' broom due to *Sphaeropsis tumefaciens* on lime trees.

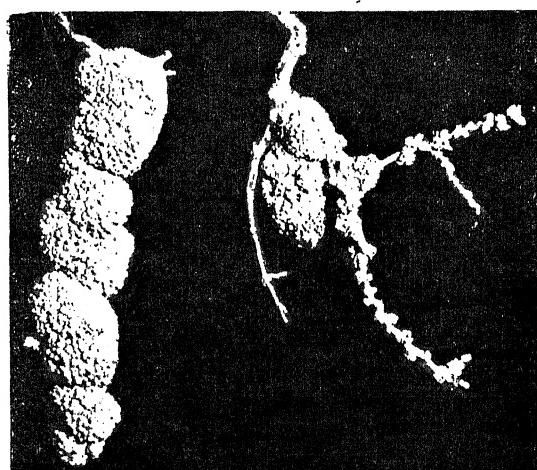


FIG. 2. Knots formed on the affected branches of lime trees due to *Sphaeropsis tumefaciens*.

of light-brown hyphae which varied from 3-5 to 5 μ in diameter. However, no fruiting bodies could be observed on the diseased branch. Large number of isolations were made from the diseased tissue on potato dextrose agar medium

and a grey culture was obtained. After 16 days, pycnidia—pin-head—like structures—developed above the surface of the agar. They bore numerous spores and were black, papillate sub-globose, erumpent, closely crowded together and $149.5-224 \times 122-191 \mu$ in size. The spores were mostly one, but rarely, two-celled, light-brown, elliptic to fusoid, rarely botuliform, measuring $16.5-29.5 \times 7-11.5 \mu$. The characters of the fungus and the symptoms it causes, closely resemble with those of *Sphaeropsis tumefaciens*, reported on lime by Hedges (1911).

Authors are grateful to Shri Samarth Raj, Director of Agriculture, Rajasthan, for facilities of work.

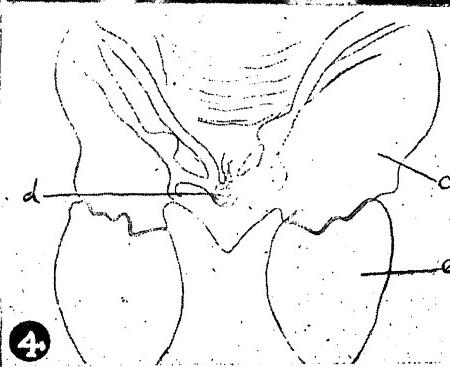
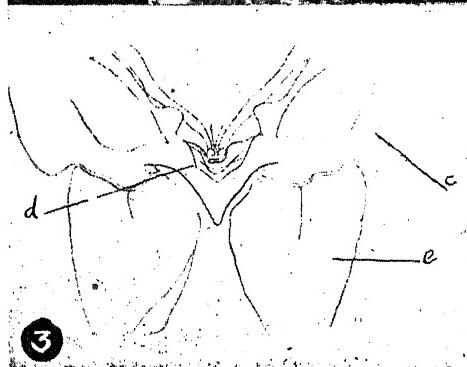
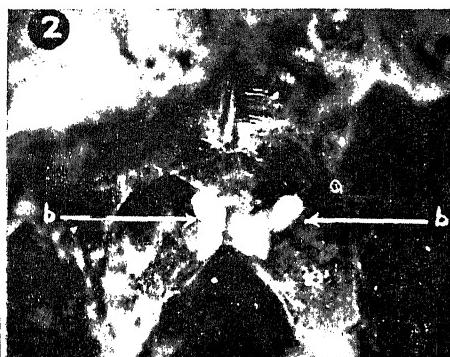
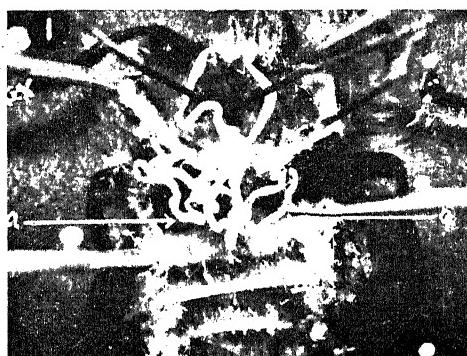
Plant Pathology Section, N. PRASAD.*
Department of Agriculture, G. C. BHATNAGAR.
Rajasthan, Udaipur,
October 26, 1960.

* Now Principal, S.K.N. Government College of Agriculture, Jobner (Rajasthan).

1. Hedges, Florence, *Phytopath.*, 1911. 1, 63.

OCCURRENCE OF THORACIC GLANDS
IN *MYLABRIS PUSTULATA* THUNBG.
(COLEOPTERA : MELOIDAE)

THERE have been numerous records of occurrence of different types of glands in various insects, but no reference to the occurrence of glands opening on the mesosternum in *Mylabris pustulata* Thunbg. or any other blister beetle could be found. In the adult male of *Mylabris pustulata* there is a pair of glands each gland being white, more or less cylindrical, tubular and about 76 mm. long with a few short branches given off from the main tubular portion (Fig. 1, a). The two glands are swollen and a little flattened just before they open into a common receptacle which in turn opens on the mesosternum. The glands are irregularly coiled and lie ventrally below the alimentary canal in the region of the first three abdominal segments and the metathorax, and proceed anteriorly between the mesosternal apophyses to open between the bases of the second coxae on the mesosternum (Fig. 3, d). The opening is surrounded by a depressed area. If the thorax



Figs. 1-4. Fig. 1. Adult male of *Mylabris pustulata* Thunbg. dissected to show the thoracic glands (a). Fig. 2. Adult female of the same species dissected to show the glands (b). Fig. 3. Mesosternum of male: c, mesosternum; d, opening of the glands; e, second coxa. Fig. 4. Mesosternum of female: c, d and e as in male.

of a live beetle is pressed gently, a whitish fluid is discharged through the opening of the glands, and this secretion is slightly acidic.

In the adult female a pair of similar glands as in the male is present, but they are rudimentary, being 4.5 mm. long. The tubular portion of the glands is very much reduced and the glands appear more or less retort-shaped, sac-like structures (Fig. 2, b).

Several hundreds of beetles of both sexes have been dissected, and the pronounced nature of the glands in the male and their ill-developed condition in the female were constantly observed in all cases, though there was a good range of variation in the length of the glands in the male. The function of the glands is not definitely known, though their unequal development in the two sexes suggests a function connected with sex—probably attraction of the female, but it could not be verified.

Grateful thanks are due to Dr. M. Puttarudraiah, Government Entomologist, for kind encouragement.

Div. of Entomology, G. P. CHANNA BASAVANNA.
Agricultural College T. S. THONTADARYA.

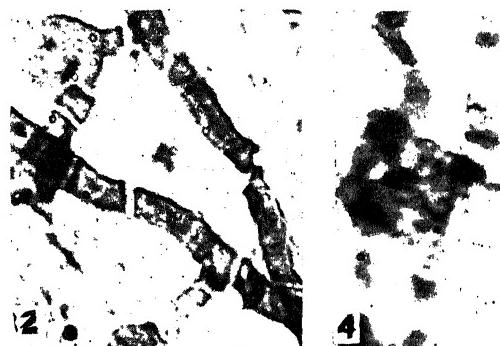
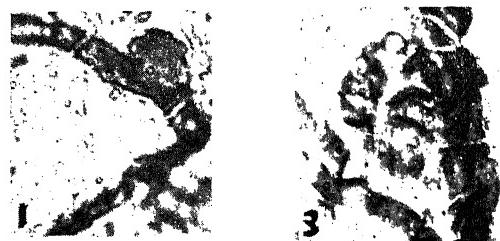
and Res. Inst.,
Hebbal, Bangalore-6, October 15, 1960.

ON TWO NEW GENERA OF FUNGI FROM TERTIARY COAL BEDS OF MALAYA

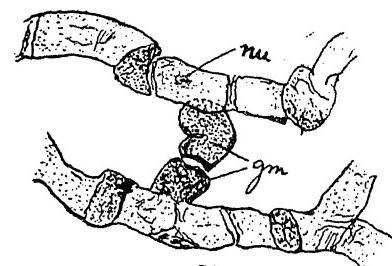
A PRELIMINARY investigation of Tertiary coal collected by one of us (B. S. T.) from Malaya in 1953 led to the interesting discovery of two fungi in fossil state, reported here.

The first shows branched septate hyphae and various stages of spore development. Figure 1 shows a spore in the initial stage, budding out from the hypha. Figure 2 shows a stalked conidiospore which has a strong resemblance with the early sporophytic stage of *Desmidiospora*,¹ Dematiaceæ—Deuteromycetes. Figure 3 shows a fully mature conidiospore with sulcate outer margin which, in spite of the absence of conidiophore, shows a close affinity with *Desmidiospora* where a long, prominent conidiophore is one of the characteristic features. The fossil fungus described here resembles *Desmidiospora* in shape, size and margin of its conidiospores. The fossil material, however, differs in having a shorter conidiophore. We regard that this fossil fungus, although not identical with *Desmidiospora*, is sufficiently nearly allied to it.

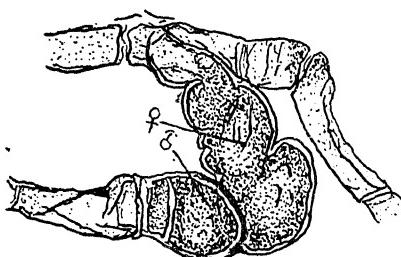
The second fungus shows profusely branched septate hyphae with various stages of sexual



FIGS. 1-4. Fig. 1. Conidiospore budding out from the septate hypha, $\times 1,107$. Fig. 2. Developing stalked conidiospore, $\times 1,107$. Fig. 3. Mature conidiospore, $\times 1,107$. Fig. 4. Mature zygote with a centrosphere, $\times 1,107$.



5



6

FIGS. 5-6. Fig. 5. Formative gametangium. gm., gametangium; nu., nucleus, $\times 1,640$. Fig. 6. Fusion of antheridial and oogonial walls, ♀, oogonium; ♂, antheridium, $\times 1,640$.

fusion. Figure 5 shows a developing curved gametangium separated from gametangiophore by a septum. It is at a stage prior to fusion between two hyphae. Figure 6 shows the fusion of the antheridial and oogonia walls. Figure 4 finally shows a zygote with a dark central area, probably the centrosphere. The stages of the fungus described above suggest an affinity with the living group Pezizaceæ, order Ascomycetes. The type of sexual fusion encountered here recalls to one's mind the sexual fusion that is found in Ascocesmis.²⁻⁵

As far as we are aware, this is the first contribution from Malayan Tertiary beds. The two fungi reported here seem to belong to two new genera. They will be described in detail elsewhere.

Botany Department, B. S. TRIVEDI.
Lucknow University, S. K. CHATURVEDI.
Lucknow, October, 31, 1960.

1. Thaxter, R., *Bot. Gaz.*, 1891, **16**, 203.
2. Van Tieghem, *Bull. Soc. Bot. Fr.*, 1876, **23**, 271.
3. Coupin, H., *Album General des Cryptogames—Fungi (Champignons)*, Premiere Volume.
4. Saccardo, P. A., *Sylloge Fungorum*, 1889, **8**, 821.
5. Clements, F. E. and Shear, C. L., *The Genera of Fungi*, The H. W. Wilson Co., New York, 1931.

ON THE STARCH CONTENT OF SOME SACCHARUM SPONTANEUM VARIANTS

QUALITATIVE examination of *S. spontaneum* variants for starch has indicated that some forms are very rich in starch, some contain comparatively little amounts and some are completely devoid of starch, and there appears to be a trend in starch content according to geographical distribution of the *spontaneum* variants. Starch is a very undesirable constituent in cane juice. It interferes with filtration and crystallisation of sugars. It is generally believed that more than 0.05% of it on weight of cane is harmful in the manufacture of sugar.

In the present study* 14 *S. spontaneum* variants collected from different geographical regions were selected and analysed for starch content in the stem and leaf portions of fully mature plants. Starch was estimated in all the samples by the method of Hanes¹ involving the use of β -amylase, adopting the same procedure as reported² earlier. Of the 14 varieties studied, SES 337 A and SES 115 A were found to contain comparatively larger amounts of starch in the stem and leaf samples. In SES 337 A and 115 A, the stem samples contained 2.473% starch on residual dry weight basis and 1.033% and 1.524% in leaf samples respectively. Glagah

and SES 90 had practically no starch in the stem sample while the leaf samples of these two varieties had respectively 0.5757% and 0.4911% starch on residual dry weight basis. For the rest of the varieties, the starch content in the stem samples varied from 0.6266% in SES 106 B to 1.711% in SES 365 while in the leaf samples the variation was from 0.3387% in SES 365 to 0.9822% in SES 106 B. SES 137 A had shown 0.8806% starch both in the stem and leaf samples. Barring a few exceptions, the variants collected from places nearer to equator appear to have comparatively lower amounts. Further detailed studies are on hand on the *S. spontaneum* variants collected and assembled from all over the continent.

Grateful acknowledgments are hereby made to Dr. N. R. Bhat, Director, for affording all facilities and for his valuable suggestions; also to Shri R. R. Panje, the then Botanist, who readily supplied the material and evinced keen interest in the work.

Sugarcane Breeding K. CHIRANJIVI RAO.
Institute, K. V. GOPALA AIYAR.
Coimbatore-7, November 29, 1960.

* List of *S. spontaneum* variants studied: (1) Glagah, (2) SES 32 A, (3) SES 90, (4) SES 98 A, (5) SES 138, (6) SES 137 A, (7) SES 106 B, (8) SES 15 A, (9) SES 118 A, (10) SES 116 A, (11) SES 186, (12) SES 297 A, (13) SES 337 A, (14) SES 365.

1. Hanes, C. H., *Biochem. Jour.*, 1936, **30**, 168.
2. Chiranjivi Rao, K. and Gopala Aiyar, K. V., *International Society of Sugarcane Technologists*, 10th Congress, Hawaii.

INDUCEMENT OF ANTER DEHISCENCE IN CO. 421, A "MALE STERILE" SUGARCANE VARIETY, BY POLLEN OF OTHER GENERA

THE anthers of Co. 421 do not dehisce usually. However, when its inflorescences (arrows) are bagged a few seedlings are obtained. The number of seedlings is much greater when the arrows are dusted with pollen of other genera like *Euchlaena*, *Coix*, etc. All these seedlings are considered to have been derived parthenogenetically.¹

In a study of the physiological effects of the pollen on the reproductive function of Co. 421, different arrows of this variety were dusted with pollen of *Euchlaena mexicana*, *Coix lachryma-jobi*, *Narenga porphyrocoma* and *Sclerostachya fusca*, respectively and bagged. Bagged, untreated arrows and unbagged, untreated arrows of Co. 421 served as controls. Four days after completion of pollen dusting, profuse anther dehiscence was observed in

arrows dusted with pollen of the different species but relatively little in the controls. The percentage of anther dehiscence in each case is given below in Table I.

TABLE I

Treatment	Percentage of open anthers		
Control :			
1. Bagged	6.3
2. Unbagged	10.2
Treated :			
1. Dusted with pollen of <i>Coix</i>	..	67.3	
2. " <i>Euchlæna</i>	..	70.4	
3. " <i>Narenga</i>	..	59.4	
4. " <i>Sclerostachya</i>		39.0	

In order to see the effect of the pollen extract, the pollen of *Euchlæna* was extracted with absolute alcohol (10 ml. per gm.), the alcohol evaporated off and the residue taken up in 25 ml. of distilled water, sprayed on arrows of Co. 421 and they were bagged. There was 89.7% anther dehiscence in them, while in the distilled water controls, there was only 7% dehiscence. It would appear that anther dehiscence is caused by the chemical stimulus from the pollen dusted.

Sugarcane Breeding Institute, C. N. BABU.
Coimbatore-7, November 21, 1960.

1. Raghavan, T. S. and Kandaswamy, P. A., *Proc. 3rd All Ind. Conf. Res. and Dev. Workers, Pusa, Part II*, 46.

PERPETUATION OF THE DOWNY MILDEW OF MAIZE (*SCLEROSPORA PHILIPPINENSIS* WESTON) ON KANS (*SACCHARUM SPONTANEUM* L.) IN INDIA

DOWNY mildew of maize caused by *Sclerospora philippinensis* Weston which is common in the neighbourhood of Delhi has been generally responsible for about 5% infection of the crop for the last few years. In view of the fact that the causal organism does not produce any oospores the mode of perpetuation of the disease was not clear. Recently Chona and Suryanarayana¹ described a downy mildew persistent on Kans (*Saccharum spontaneum* L.) a hardy perennial grass in this part of the country. They reported that the fungus was found in all parts of the plant, thus indicating systemic infection. On the basis of morphological studies, they identified it as *Sclerospora philippinensis* and suggested that it may pass under suitable conditions to maize causing

downy mildew. The appearance of downy mildew on maize crop at the Indian Agricultural Research Institute first near the infected clumps of Kans supports this view. During September 1960, the writer has been able to transmit the disease from 'Kans' to maize by inoculating the latter by sporangia collected from the diseased 'Kans' clumps. Inoculations were carried out by placing sporangial suspension in distilled water in the leaf whorl of the seedlings and also by applying it on the leaf surface. The inoculated plants were kept in a moist chamber which was placed in the open. A few uninoculated seedlings in moist chambers kept side by side served as control. All the 24 seedlings (in two-leaf stage) inoculated showed typical symptoms of downy mildew, viz., chlorosis of leaves and development of downy growth of sporangiophores on the leaf surface. Characteristic chlorotic mottle appeared on the fourth day while fully developed sporangiophores bearing sporangia were observed on the ninth day. The controls remained healthy throughout these tests. Microscopic examination showed that the germ tubes produced by the sporangia penetrated through the stomata of the inoculated leaves and gave rise to branched mycelium which spread rapidly within the intercellular spaces of the leaf. Haustoria of the fungus were observed in the host cells in several cases.

I am grateful to Dr. B. L. Chona, Mycologist, for his keen interest and help during the course of these experiments.

Division of Mycology D. SURYANARAYANA.
and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi, December 12, 1960.

1. Chona, B. L. and Suryanarayana, D., *Indian Phytopath.*, 1955, 8 (2), 209.

MANGO BUNCHY-TOP AND THE ERIOPHYID MITE

NARASIMHAN (1954) was the first to record the occurrence of *Eriophyes* sp. on mango inflorescence round about Poona, and he stated that the eriophyid mite was responsible to cause the malformation of panicles. Malformation of mango inflorescence has been noted by several workers in North India, and Sattar (1946) stated that this was doing serious damage in the Punjab. Nirvan (1953) stated that though mango malformation has already been reported by several workers he was reporting 'bunchy-top' of young mango seedlings for the first time. Tripathi (1954) gave a history of the

disease, and discussed the usage of the terms 'bunchy-top' and 'malformation'. He came to the conclusion that the former name should be applied to cases of vegetative malformation as was described by Nirvan (1953), and the latter term to the floral deformities. However, he considered that the same disease caused these two types of symptoms. Narasimhan (1959) observed that the eriophyid mite, which he recorded on mango inflorescence earlier (1954), spent its life within the tissues of axillary buds after the flowering season was over, and also suggested that the disease could be controlled by removal of affected inflorescences. In the present note the preliminary observations made and the results of certain experiments carried out by the authors are recorded.

Around Bangalore the 'bunchy-top' was observed only on young seedlings raised from mango seeds for using these seedlings for grafting purposes, and was not noticed on trees. The cluster of buds occur not only at the top of seedlings, but also in the axils of branches and leaves. Malformation of mango inflorescence, though occurring rarely here and there, is not so far such a serious malady as is reported from certain areas of North India.

With a view to see whether the eriophyid mite, usually found on the malformed twigs ('bunchy-top') of mango seedlings, can cause similar malformation of twigs on healthy seedlings, mites taken from malformed twigs were introduced on to newly sprouting leaf-buds at the terminal regions of mango seedlings. For this purpose, three seedlings, which did not show any malformed twigs nor the presence of the eriophyid mite, were selected in a place well away from the gardens showing such malformed mango plants. The eriophyid mites taken from malformed twigs were carefully introduced by means of a fine camel hair brush on to just sprouting leaf-buds of the selected healthy plants. The plants were enclosed individually in cages covered with thin muslin cloth. These plants were kept under regular observation. The leaf-buds on to which mites were introduced did not result in normal leaves. New buds began to arise by the side of the original buds, and even these buds did not develop properly so that at the end of three months after the introduction of the eriophyid mite, the top of the seedlings presented a crowded cluster of buds (Fig. 1) as is usually found on malformed mango seedlings in nature.

The above experiment shows that the eriophyid mite can bring about twig malformation on

healthy mango seedlings, similar to the one seen in nature. Whether this twig malformation is the direct result of the feeding injury done



FIG. 1. Experimental mango seedling showing 'bunchy-top' induced by the eriophyid mite. Inset: top portion enlarged.

by the mite as is implied by Narasimhan (1954) or due to a virus has to be investigated. If it is due to a virus, then it is possible that the eriophyid mite may be acting as a vector.

Further work in this direction is in progress.

M. PUTTARUDRIAH.

G. P. CHANNA BASAVANNA.

Division of Entomology,
Department of Agriculture,
Bangalore (Mysore State),
December 3, 1960.

1. Narasimhan, M. J., *Curr. Sci.*, 1954, 23 (9), 297.
2. —, *Ibid.*, 1959, 28 (6), 254.
3. Nirvan, R. S. *Sci. and Cult.*, 1953, 18 (7), 335.
4. Sattar, A., *Punjab Fruit J.*, 1946, 10, 56.
5. Tripathi, R. D., *Indian J. Hort.*, 1954, 11 (4), 122.

RELATIONSHIP BETWEEN STRUCTURAL AND TOPOGRAPHIC TRENDS IN KONDAPALLE AREA

WHILE conducting systematic mapping work in the Kondapalle area, the author has observed that there is some relationship between the major strike directions of the rock types and

arrows dusted with pollen of the different species but relatively little in the controls. The percentage of anther dehiscence in each case is given below in Table I.

TABLE I

Treatment	Percentage of open anthers		
Control:			
1. Bagged	6.3
2. Unbagged	10.2
Treated:			
1. Dusted with pollen of <i>Coix</i>	..	67.3	
2. " <i>Euchlæna</i>	..	70.4	
3. " <i>Narenga</i>	..	59.4	
4. " <i>Sclerostachya</i>	..	39.0	

In order to see the effect of the pollen extract, the pollen of *Euchlæna* was extracted with absolute alcohol (10 ml. per gm.), the alcohol evaporated off and the residue taken up in 25 ml. of distilled water, sprayed on arrows of Co. 421 and they were bagged. There was 89.7% anther dehiscence in them, while in the distilled water controls, there was only 7% dehiscence. It would appear that anther dehiscence is caused by the chemical stimulus from the pollen dusted.

Sugarcane Breeding Institute, C. N. BABU.
Coimbatore-7, November 21, 1960.

1. Raghavan, T. S. and Kandaswamy, P. A., *Proc. 3rd All Ind. Conf. Res. and Dev. Workers, Pusa, Part II*, 46.

PERPETUATION OF THE DOWNY MILDEW OF MAIZE (*SCLEROSPORA PHILIPPINENSIS* WESTON) ON KANS (*SACCHARUM SPONTANEUM* L.) IN INDIA

DOWNY mildew of maize caused by *Sclerospora philippinensis* Weston which is common in the neighbourhood of Delhi has been generally responsible for about 5% infection of the crop for the last few years. In view of the fact that the causal organism does not produce any oospores the mode of perpetuation of the disease was not clear. Recently Chona and Suryanarayana described a downy mildew persistent on Kans (*Saccharum spontaneum* L.) a hardy perennial grass in this part of the country. They reported that the fungus was found in all parts of the plant, thus indicating systemic infection. On the basis of morphological studies, they identified it as *Sclerospora philippinensis* and suggested that it may pass under suitable conditions to maize causing

downy mildew. The appearance of downy mildew on maize crop at the Indian Agricultural Research Institute first near the infected clumps of Kans supports this view. During September 1960, the writer has been able to transmit the disease from 'Kans' to maize by inoculating the latter by sporangia collected from the diseased 'Kans' clumps. Inoculations were carried out by placing sporangial suspension in distilled water in the leaf whorl of the seedlings and also by applying it on the leaf surface. The inoculated plants were kept in a moist chamber which was placed in the open. A few uninoculated seedlings in moist chambers kept side by side served as control. All the 24 seedlings (in two-leaf stage) inoculated showed typical symptoms of downy mildew, viz., chlorosis of leaves and development of downy growth of sporangiophores on the leaf surface. Characteristic chlorotic mottle appeared on the fourth day while fully developed sporangiophores bearing sporangia were observed on the ninth day. The controls remained healthy throughout these tests. Microscopic examination showed that the germ tubes produced by the sporangia penetrated through the stomata of the inoculated leaves and gave rise to branched mycelium which spread rapidly within the intercellular spaces of the leaf. Haustoria of the fungus were observed in the host cells in several cases.

I am grateful to Dr. B. L. Chona, Mycologist, for his keen interest and help during the course of these experiments.

Division of Mycology D. SURYANARAYANA.
and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi, December 12, 1960.

1. Chona, B. L. and Suryanarayana, D., *Indian Phytopath.*, 1955, 8 (2), 209.

MANGO BUNCHY-TOP AND THE ERIOPHYID MITE

NARASIMHAN (1954) was the first to record the occurrence of *Eriophyes* sp. on mango inflorescence round about Poona, and he stated that the eriophyid mite was responsible to cause the malformation of panicles. Malformation of mango inflorescence has been noted by several workers in North India, and Sattar (1946) stated that this was doing serious damage in the Punjab. Nirvan (1953) stated that though mango malformation has already been reported by several workers he was reporting 'bunchy-top' of young mango seedlings for the first time. Tripathi (1954) gave a history of the

disease, and discussed the usage of the terms 'bunchy-top' and 'malformation'. He came to the conclusion that the former name should be applied to cases of vegetative malformation as was described by Nirvan (1953), and the latter term to the floral deformities. However, he considered that the same disease caused these two types of symptoms. Narasimhan (1959) observed that the eriophyid mite, which he recorded on mango inflorescence earlier (1954), spent its life within the tissues of axillary buds after the flowering season was over, and also suggested that the disease could be controlled by removal of affected inflorescences. In the present note the preliminary observations made and the results of certain experiments carried out by the authors are recorded.

Around Bangalore the 'bunchy-top' was observed only on young seedlings raised from mango seeds for using these seedlings for grafting purposes, and was not noticed on trees. The cluster of buds occur not only at the top of seedlings, but also in the axils of branches and leaves. Malformation of mango inflorescence, though occurring rarely here and there, is not so far such a serious malady as is reported from certain areas of North India.

With a view to see whether the eriophyid mite, usually found on the malformed twigs ('bunchy-top') of mango seedlings, can cause similar malformation of twigs on healthy seedlings, mites taken from malformed twigs were introduced on to newly sprouting leaf-buds at the terminal regions of mango seedlings. For this purpose, three seedlings, which did not show any malformed twigs nor the presence of the eriophyid mite, were selected in a place well away from the gardens showing such malformed mango plants. The eriophyid mites taken from malformed twigs were carefully introduced by means of a fine camel hair brush on to just sprouting leaf-buds of the selected healthy plants. The plants were enclosed individually in cages covered with thin muslin cloth. These plants were kept under regular observation. The leaf-buds on to which mites were introduced did not result in normal leaves. New buds began to arise by the side of the original buds, and even these buds did not develop properly so that at the end of three months after the introduction of the eriophyid mite, the top of the seedlings presented a crowded cluster of buds (Fig. 1) as is usually found on malformed mango seedlings in nature.

The above experiment shows that the eriophyid mite can bring about twig malformation on

healthy mango seedlings, similar to the one seen in nature. Whether this twig malformation is the direct result of the feeding injury done



FIG. 1. Experimental mango seedling showing 'bunchy-top' induced by the eriophyid mite. Inset: top portion enlarged.

by the mite as is implied by Narasimhan (1954) or due to a virus has to be investigated. If it is due to a virus, then it is possible that the eriophyid mite may be acting as a vector.

Further work in this direction is in progress.

M. PUTTARUDRIAH.

G. P. CHANNA BASAVANNA.

Division of Entomology,
Department of Agriculture,
Bangalore (Mysore State),
December 3, 1960.

1. Narasimhan, M. J., *Curr. Sci.*, 1954, 23 (9), 297.
2. *Ibid.*, 1959, 28 (6), 254.
3. Nirvan, R. S. *Sci. and Cult.*, 1953, 18 (7), 335.
4. Sattar, A., *Punjab Fruit J.*, 1946, 10, 56.
5. Tripathi, R. D., *Indian J. Hort.*, 1954, 11 (4), 122.

RELATIONSHIP BETWEEN STRUCTURAL AND TOPOGRAPHIC TRENDS IN KONDAPALLE AREA

WHILE conducting systematic mapping work in the Kondapalle area, the author has observed that there is some relationship between the major strike directions of the rock types and

the general trend of the hill ranges. To understand the exact relationship between them, a topographic analysis has been made at the outset, on the lines suggested by Chapman.¹ A small area of 6.25 sq. miles comprising the southernmost part of the hill ranges has been chosen and 148 slope measurements were made on a 4"=1 mile topo-sheet with a contour interval of 50'. The traverse method was employed and eleven traverses were run with one inch interval in a E-W direction, nearly perpendicular to the main trend of the ridges. Along each traverse line, measurements were made for every half an inch with a slope scale which has been specially constructed. The results obtained in this quantitative slope study have been presented, following Chapman's method, in the form of a statistical slope orientation (SSO) diagram (Fig. 1).

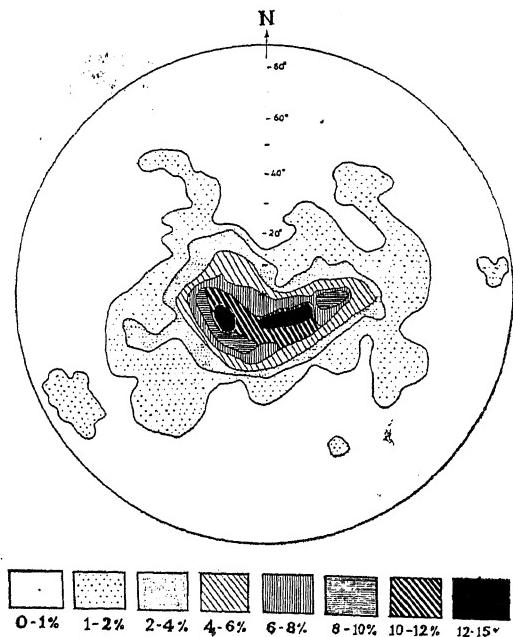


FIG. 1. SSO diagram, southern part of the Kondapalle hill ranges; slope angles are marked.

This SSO diagram clearly brings out all the major features and also makes the minor features, not clearly expressed in the topographic map, to appear more conspicuously. The symmetry of the diagram is essentially triclinic but not far from monoclinic. The diagram shows two maxima reaching a concentration of about 22% (mode). The general absence of sharp breaks in slope is indicated by the more or less continuous decrease in slope angle frequency with the increase in slope angle.

Further, 187 foliation and 94 joint directions

of the same area, together with the 148 slope strikes, are diagrammatically represented (Fig. 2) showing the relative frequencies of the same in different directions. There is a remarkable coincidence between the major slope strike

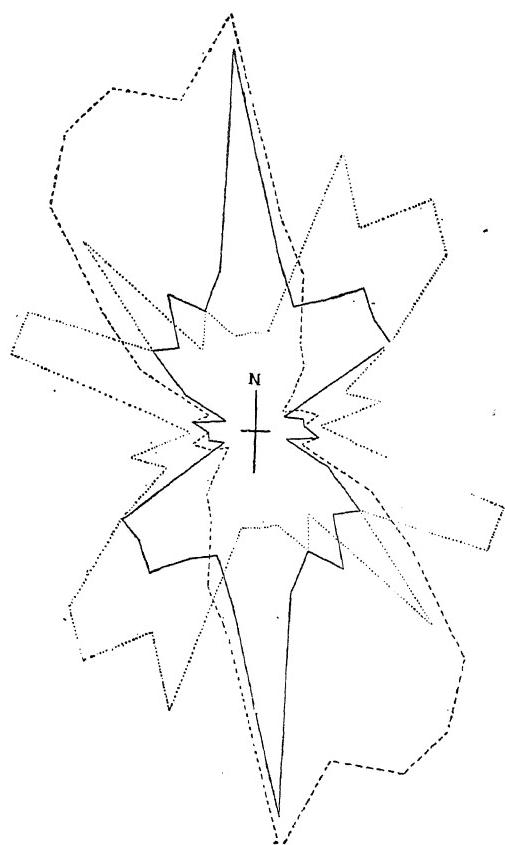


FIG. 2. Diagram showing the frequencies of the slope strikes (solid line), foliation directions (dashed line) and joint directions (dotted line).

direction and foliation direction ($N 5^\circ W$). It is interesting to note that there are two sets of joints which are nearly at right angles; one of these two striking $N 35^\circ E$, peculiarly enough, coincides with the minor slope strike, while the other striking $N 135^\circ E$ is slightly at an angle (10°) to the other minor slope. It is also noticed that where the foliation frequency is generally less, the joints are at maximum. It can, hence, be surmised that the major trend of the hills is dominantly controlled by the foliation directions, while the minor slopes are influenced by the joint pattern.

My thanks are due to Dr. S. Balakrishna for his help and guidance.

Geology Dept.,
Osmania University,
Hyderabad-7,

CH. LEELANANDAM.

December 9, 1960.

1. Chapman, C. A., *Am. J. Sci.*, 1952, 250, 428.

REVIEWS

An Introduction to Homological Algebra. By D. G. Northcott. (Cambridge University Press), 1960. Pp. xi + 282. Price 42 sh. 6 d.

Professor Northcott, author of a remarkable Cambridge tract on *Idéal Theory*, is now to be thanked for a no less remarkable Introduction to *Homological Algebra*.

From the time of its creation by H. Poincaré until recently, the discipline called first Combinatorial Topology, then Algebraic Topology, grew as a mixed structure in the sense of Bourbaki, its purpose being to derive topological invariants from the analysis of certain algebraic structures. These had to be linked up in a certain manner to manifolds, or to subsets of topological spaces and, to realize such an association, various, mostly disconnected, methods were available. For a long time the need of a more unified treatment was keenly felt but it is only during the last twenty years or so that great progress was made to achieve it. As a consequence the conviction gradually gained ground that Algebraic Topology was more than a mere combination of two well-known structures; that it was pregnant with an altogether new branch of Algebra. In 1956, H. Cartan and S. Eilenberg published their celebrated *Homological Algebra*, a first treatise on this new branch and an astonishing feat because, dealing with a newly born theory, it was setting it forth in a state of remarkable maturity.

Now, although carefully and clearly written, this treatise was assuming on the part of the reader a good deal of familiarity with Modern Algebra and, to a certain extent, with Algebraic Topology. That is why the book under review should be most welcome by students about to start on research for it does not take for granted more than an elementary knowledge of groups and rings. In fact the first two chapters are concerned only with fundamentals of General Algebra, in particular with tensor products, (O)- and exact sequences. Homological Algebra proper begins only with Chapter 3 which is about categories and functors. The important notions of Homology Functor and of Connected Homomorphisms are dealt with in Chapter 4. The author does not derive them, as it is usually done, from the theory of modules with differential operators. Following Yoneda he prefers to start with the

notions of diagrams over a ring and of functors on translation categories; the case of a particular diagram yields the homology functor. In spite of its theoretical interest such an approach may fail to satisfy inexperienced algebraists. The chapter ends with a brief mention of homotopy. One may regret that such an important notion, and also that of homotopy operator, should receive so little attention. Chapter 5 treats of complexes and resolutions, particularly of projective and injective resolutions, of modules and of sequences of modules. Now the ground having been fully prepared Chapter 6 introduces the central notions of Homological Algebra: functors of complexes and derived functors. Chapter 7 makes a detailed study of torsion and extension functors, the most important derived functors.

It was likely that the author's intention was not to burden the student with too many new notions. This would explain why no mention is made of spectral sequences. Fortunately those who wish to acquire a good grasp of them may now consult the *Théorie des Faisceaux* by R. Godement (Hermann, Paris) published almost at the same time as the book under review.

Chapter 8 is about various refinements and the last two chapters are devoted to two noteworthy applications: the theory of homology and of cohomology of groups or monoids and the theory of homological dimension, as well as of global dimension of noetherian rings. Chapter 9 gives an excellent account of the research work carried out recently, mostly after 1956, regarding the latter.

This is a lucid and scholarly Introduction to Homological Algebra and it cannot but be too warmly recommended. Its admirable get-up does great credit to the Cambridge University Press.

C. RACINE.

Foundations of Modern Analysis. By J. Dieudonné. (Institut des Hautes Études Scientifiques, Paris. Published by Academic Press, New York and London), 1960. Pp. vii + 361. Price 68 sh.

The book under review is the tenth contribution to the Pure and Applied Mathematics series of Monographs and Text-books edited

by Paul A. Smith and Samuel Eilenberg on behalf of the Academic Press. The book is an outgrowth of course of lectures on Modern Analysis delivered by the author at the Northwestern University during 1956-57. The main purpose of writing this book is best explained in the following words of the author about the motive of the course of lectures at the Northwestern University : "The purpose of the course was two-fold : to provide necessary elementary background for all branches of modern mathematics involving analysis and to train the students in the use of this most fundamental mathematical tool of our time—the axiomatic method".

The book is divided into eleven chapters with the headings Elements of the Theory of Sets ; Real Numbers, Metric Spaces ; Additional Properties of the Real line ; Normal Spaces ; Hilbert Spaces ; Spaces of Continuous Functions ; Differential Calculus ; Analytic Functions and Application of Analytic Functions of Plane Topology ; Existence Theorems ; and Elementary Spectral Theory.

The author throughout lays emphasis on the "conceptual" aspect of the notions rather than the "Computational" aspect. Although the book includes considerable material generally treated in courses on "Advanced Calculus", the point of view with which this material is presented is entirely different, as the fundamental concepts of function theory and of calculus have been introduced within the framework of a theory which is sufficiently general to reveal the scope, the power and the true nature of these concepts. At no stage does the author resort to "geometric intuition" in the formal proofs of the theorem. The book is self-contained and a reader needs only the knowledge of the first rules of mathematical logic, mathematical induction, and fundamental properties of the set of integers and of the elements of linear algebra in addition to a good working knowledge of classical analysis as a prerequisite for the study of the book. In order to achieve economy in space the author introduces from the very outset the accepted notations of modern mathematics. Besides, a reader, who has worked through this introductory course on Modern Analysis, will not find himself lost in the maze of the notations when he takes to the study of books on higher mathematics.

The treatment of the various topics is lucid, clear and rigorous. The book contains a large number of well-chosen problems. The problems may be regarded in most cases as supplementary to the basic text so that it is binding on any

serious student of the subject to work out all these problems. This will not only enrich his knowledge of the subject but will also give him confidence in his grasp of the fundamentals.

The book is a valuable addition to the list of books on modern analysis. In the opinion of the reviewer, the book will be found very suitable as a text-book for the courses on Modern Analysis in the Indian Universities.

P. L. BHATNAGAR.

Industrial Electric Furnaces and Appliances.

By V. Paschkis and John Persson. (Interscience Publishers, New York, London), 1960. Second Edition. Pp. 607. Price \$ 24.00.

The revised and enlarged second edition of *Industrial Electric Furnaces and Appliances* by V. Paschkis and John Persson is the consolidated presentation of the earlier two-volumed first edition which came out without the collaboration of the second author named in this edition. Study and design of electric furnaces in general covering as it does thermal and electrical problems apart from the chemical and metallurgical aspects needs a two-pointed view and this has been well met by the two authors who are experts in their respective fields.

The book is divided conveniently into 5 chapters.

The first chapter which is designated as the general part covers the first principles of heat transfer—an aspect often neglected by both the designer and the operators of furnaces—electrical laws, and the economic considerations from the industrial standpoint.

The second chapter deals with arc furnaces, specifically the open arc furnaces, submerged arc furnaces and some special types, like skull melting furnaces, cold mould furnaces, etc. In all these cases, there is evidence of a systematic presentation starting with basic principles, thermal and electrical considerations, general descriptions, furnaces parts and operation. Oxygen lancing and indirect stirring which is becoming increasingly important have also been rightly touched upon. Also the empirical data derived from a wide variety of metallurgical processes have been correlated with dimensional analysis, giving a new approach to the whole problem.

Resistance furnaces and appliances are discussed next under a separate chapter, giving details of indirect heat furnaces of the conduction, convection and the radiation types ; direct heat furnaces and the resistance appliances and their role, significance and application.

In chapter IV is discussed the induction and dielectric heating giving details of general aspects, power supply, types of furnaces and appliances, design and economic considerations. The calculation aspects have been excellently dealt with and this would greatly help in understanding the basic thermal and electric principles.

Lastly, the fifth chapter deals with the selection of furnaces, touching upon the methods of selection, energy losses, heating and melting processes.

By and large the book deals only with thermal and electrical problems with an accent on calculations programmed for digital computers and the direct analog computers, and is of significance to the electrical furnace builders and operators and no less to those of fuel-fired ones. The text contains some 151 graphs, 233 diagrams, 43 tables and 51 illustrations.

The book has been very well got up and is recommended not only to the builders and designers of electrical furnaces but also to the metallurgical engineer.

A. A. K.

Representations of Primes by Quadratic Forms.

Prepared by Hansraj Gupta, M. S. Cheema, A. Mehta and O. P. Gupta. Edited by J. C. P. Miller. (Published by the Royal Society at the University Press, Cambridge), 1960. Pp. xxiv + 135. Price 45 sh. net.

The tables give, for primes p not exceeding 100,000 the representation of either p or $2p$ in the forms $a^2 + 5b^2$, $a^2 + 6b^2$, $a^2 + 10b^2$, $a^2 + 13b^2$ whenever any such representation exists. The tables also give, in such circumstances, the least value of n such that $n^2 + 5$, 6, 10 or 13 is divisible by p or $2p$, the quotient k being given also.

These results provide useful numerical evidence concerning the erratic and interesting way in which these quantities vary and may contribute to the understanding of such unsolved questions as 'Is the number of primes of the form $n^2 + 5$ or $n^2 + 6$, etc., infinite or finite ?

The tables contain an introduction which outlines the theory of quadratic fields and of the factorization of ideals in such fields.

The Living Body, 4th Edition. By C. H. Best and N. B. Taylor. (Chapman & Hall Ltd., London, W.C. 2), 1959. Pp. 756. Price 45 sh.

Human physiology is always a fascinating subject having universal interest. It is one of

those everwidening fields of study where the more we know the more there is yet to know.

The rapid advances that have been made during the last decade in the various disciplines of Biology, Biochemistry and Medicine have so changed our conceptions regarding the defensive mechanism of the human body against diseases, the process of immunity, the metabolic activity of the body and the theory of nutrition that any book written on the subject soon becomes out of date. One should also be wary in accepting new findings till they have been well established and passed from the field of controversy. These facts have been taken into account in preparing the Fourth Edition of the book *The Living Body—A Text in Physiology*.

This edition has also been given a new look in size and get-up which readers will find more convenient to handle than the previous edition. A number of new figures have been added and many of the old ones have been redrawn and improved. A comprehensive pronouncing glossary of over twenty pages has been appended to the text.

A. S. G.

Radar Meteorology. By Louis J. Battan. (University of Chicago Press, Cambridge University Press, London N.W. 1), 1959. Pp. xi + 161. Price 45 sh.

Since World War II and especially during the last decade radar meteorology has developed phenomenally. This development has taken place mostly in U.S.A., thanks to a relatively small group of organizations which had all the facilities for productive research in this field. The literature on the subject, however, is scattered in journals and out-of-print conference reports. Hence the present publication by one who can write with authority on the subject, setting forth for the first time in book form a summarized account of the important advances that have been made in radar meteorology during the last fifteen years, will be welcomed by practising meteorologists and students of meteorological science.

The 150-page book contains 15 chapters. The first chapter gives a brief account of the principles of radar and the three chief types of indicators or display scopes used in weather radar, namely, the simple A-scope used to identify the source of the back-scattered energy, the PPI (plan-position indicator) scope specially useful for observations of severe storms, and the RHI (range-height indicator) scope particularly useful in cloud studies. Then

there are chapters on properties, propagation, and attenuation of electromagnetic waves. These are followed by chapters on micrometeorology, namely, radar detection of spherical and non-spherical particles and precipitation measurements. Use of radar in cloud physics research has been somewhat extensively dealt with. A chapter has been devoted to radar in mesometeorology, a term used to designate medium-scale meteorological phenomena having space and time scales between the microscale and the large scale. In this comes the study of thunderstorms, squall lines and tornadoes. This is followed by a chapter on radar study of larger-scale weather systems and precipitation patterns associated with hurricanes and cyclones. Finally there is a chapter on special instrumental techniques.

The book which is profusely illustrated will be an indispensable guide book for all those working on radar meteorology.

A. S. G.

The Plasma Proteins, Vol. II. Biosynthesis, Metabolism and Alterations in Disease. Edited by F. W. Putnam. (Academic Press, New York and London), 1960. Pp. xv + 518.

The book gives an excellent account by various authorities on topics relating to biosynthesis, metabolism and alterations in disease of the plasma proteins. The opening chapter contains an account of the structure and functions of human serum lipoproteins by F. T. Lindgren and A. V. Nichols. A valuable contribution by W. H. Fishman brings together results of extensive studies on plasma enzymes. H. A. Antoniades has given a critical account of hormones found in plasma in the normal state. The subject of blood coagulating system present in plasma has been ably dealt with by R. G. Macfarlane. The comparative biochemistry and embryology of plasma proteins found in different animals have been critically reviewed by R. L. Engle and K. R. Woods. The subject of biosynthesis of plasma proteins has been exhaustively dealt with by H. S. Anker. The fascinating subject of alterations in plasma proteins in disease has been critically reviewed by M. L. Petermann. F. W. Putnam has given an account of the subject of abnormal serum globulins. The important subject of genetic alterations in plasma proteins of man has been dealt with by D. Gitlin and C. A. Janeway.

In the preface to the book, the editor F. W. Putnam has stated that the purpose of the treatise is to present an authoritative, inter-

pretive and integrative account of the subject. The reviewer feels that the above objectives have been amply achieved by the different contributors and the editor. The book will continue to serve for a long time to come as a volume of reference to biochemists and clinicians interested in the subject. The editor and the contributors are to be complimented in bringing out this volume of outstanding value in a field in which rapid advances have been made during recent years.

M. SWAMINATHAN.

Advances in Organic Chemistry : Methods and Results (Vol. 2). Edited by Ralph, A. Raphael, Edward C. Taylor and Hans Wynberg. (Interscience Publishers, New York), 1960. Pp. vii + 504. Price \$ 15.00

The useful publications under "Advances in Organic Chemistry" have been continued and Volume 2 has appeared with the following contents: Alkenylmagnesium Halides, Dialkoxydihydrofurans and Diacyloxydihydrofurans as Synthetic Intermediates, Ethynyl Ethers and Thioethers as Synthetic Intermediates, Ketene in Organic Synthesis, Nuclear Magnetic Resonance in Organic Structural Elucidation, Hydrogenation-Dehydrogenation Reactions, Ultra-violet Photochemistry of simple unsaturated systems, The Chemistry of muscarine. As a man working in the field, I have already been benefited by the appearance of this Volume. Particularly welcome is the inclusion of "The Chemistry of Muscarine", and I would look forward to the inclusion of the following topics in future volumes : Gibberellic Acid, Recent Developments in the Application of Borohydrides and Diborane, Zone Refining Technique.

D. K. BANERJEE.

Darwin's Place in History. By C. D. Darlington. (Oxford, Basil Blackwell; Macmillan & Co., Ltd., London, W.C. 2), 1959. Pp. iv + 101. Price 9 sh. 6 d.

The centenary of the publication of the "Origin of Species" by Charles Darwin was celebrated recently. At such a time there is usually an attempt to gloss over the failings and to highlight the achievements. The passage of a century should enable a critical appraisal of Darwin's place in history without being troubled by the feeling that a great figure should not be dissected. The book under review, therefore, is unusual in that it attempts such analysis.

The biologists of the 19th century were rather chary about "quoting the more important ante-

cedent authorities". Darwin was no exception. The reader of the *Origin* is given the impression that the whole problem of evolution came to the fore only with the voyage of the Beagle and that Darwin's theory was something new. The passing reference to the views of his grandfather, Erasmus Darwin, gives the impression that he merely "anticipated the erroneous grounds of opinion and the views of Lamarck" (p. 33). This does not appear to be an accurate evaluation. Erasmus Darwin while conceding that heredity may be soft and may be capable of alteration by the environment also suggested that changes can occur as a result of competition and selection and envisaged even "sexual selection", an idea elaborated later by his grandson.

The belief that heredity may be soft, that the environment may direct the variation even before it arises and that inheritance of the effects of use and disuse may be responsible for evolution was nothing new. But when Lamarck combined these ideas into a working hypothesis, biologists suddenly became aware of the opposition between the roles of direction and selection in evolution and the possibility or otherwise of experimental verification.

The first to record their disagreement were three medical men, Wells, Lawrence and Prichard. Lawrence, a Professor at the Royal College of Surgeons, emphasized in his book, *Natural History of Man* (1819), that "neither climate nor food nor civilization nor government had any influence on the differentiation of races" (p. 18). This scientific approach to the problem ignoring, as it did, persons and properties became anathema to the church and state. Since persecution and ruin faced him, he wisely suppressed his book and prospered in life!

"Darwin's unawareness of what his contemporaries were thinking matched his unawareness of what his predecessors had written" (p. 27). The views of Darwin and Wallace do not also appear to be identical. Wallace repudiated the views of Lamarck. Darwin, while emphasizing the role of natural selection, conceded the possibility of the inheritance of acquired characters. "He leaves open a line of retreat from caused to directed, the line he was later with unnoticed steps to follow" (p. 26).

Samuel Butler tried to destroy, what he called, the *myth of Darwinism* by indicating how the ideas of Darwin were nothing new. Yet another source unacknowledged by Darwin has recently been brought to light. Edward Blyth analysed in three articles (1835-37) a

variety of problems relating to evolution with a view to substantiate his belief in the stability of species.

Jenkin, a Professor of Engineering in London, marshalled arguments against evolution in general and natural selection in particular. He emphasized that variations may be of different types, that they may be abrupt and discontinuous and that they may breed true without blending quite contrary to what was envisaged by Darwin. Deferring to Jenkin's arguments, Darwin gradually retreated from natural selection in successive editions of the *Origin* and presented the view that the environment may cause as well as direct the change. His theory of pangenesis was intended to bolster up the Lamarckian mode of inheritance. Darwin's theory of evolution became thus very difficult to "distinguish from anybody else's theory of evolution" (p. 40).

Some of the discoveries of Mendel were anticipated by Charles Naudin in a paper which appeared a year earlier (1864) than that of Mendel (1865). Hooker invited Darwin's attention to the above publication. Unable as Darwin was, to appreciate the impact of the earlier discoveries on cellular basis of reproduction or the difference between one and two grain pollinations or between the first and second generation hybrids, the particulate theory of heredity was not appreciated by Darwin. Inheritance of acquired characters is inconceivable if one accepts Mendelian interpretation of heredity.

This 100-page essay on Darwin's place in history is a challenging booklet and provides stimulating reading. But how far the reader will agree with the different issues raised is a moot point.

M. K. SUBRAMANIAM.

Report of the Rothamsted Experimental Station for 1959. (Harpendon, Herts, England). Pp. vii + 103. Price 10 sh.

Rothamsted Experimental Station needs no introduction to Agricultural Research workers. The Report of the Station for 1959 gives as usual the summary of work done in the various departments now over twelve in number. The report reveals a number of problems, influencing the range and aim of research and the attention bestowed to meet the needs of the farmer. In addition to distinctly useful subjects as fertiliser use and plant protection, the report deals with a number of subjects of ultimate importance, such as international language for computers, identity of biological active materials, potential

plant nutrients and virus distribution in infested plants.

A remarkable instance, how a warning to spray the beet-root crop against Aphids increased the yield by 25% on an average, and in some cases, even 100% is reported. It is mentioned that the spraying technique was initiated only in 1957. The short general report of the Director of the Institute at the beginning of the volume, on "the range and aim of research" is a valuable summary of the position of Agricultural Research and would prove extremely useful to those who are still sceptical about the practical values of Agricultural research. Another good feature of the report is a valuable abstract of scientific papers given at the end.

The report contains information of fundamental value and it is certain a perusal of this report from the oldest and the most famous agricultural research centre will be of great interest to workers all over the world. [K. R.

Medicinal Chemistry. (2nd Edition). Edited by Alfred Burger. (Interscience Publishers, New York), 1960. Pp. xiii + 1243. Price \$ 37.50.

'Medicinal chemistry' is a branch of science rather difficult to define and to delimit. A medicinal chemist must be experienced in organic chemistry, physical chemistry, biochemistry, pharmacology, microbiology and many phases of medicinal therapeutics. Besides isolation, characterization, elucidation of the structure and the synthesis of compounds likely to be helpful in alleviating suffering, medicinal chemistry is also concerned with the understanding of the chemical and biological mechanisms involved in its action and in establishing relationship between chemical structure and biological activity.

Rapid development in all these fields during the last decade has necessitated the publication of the second edition of this comprehensive treatise. The extremely difficult task of synthesizing and presenting the vast material from such varied disciplines in a lucid manner has been ably handled. Assistance of more than thirty contributors has been utilised in presenting the specialized topics discussed in this volume.

The volume is not merely a compendium on drugs; the scope of the text envisages structural analysis and synthesis of important medicinal chemicals; briefly presents the methods of biological testing; and discusses biochemical mechanisms of drug action.

The book is addressed principally to the more advanced readers. The contribution by a large number of scientists, specialists in their own domain, has given the volume a status of an authoritative treatise, to be considered as a standard work of reference in medicinal chemistry.

M. SIRSI.

Books Received

Advances in Analytical Chemistry and Instrumentation (Vol. I). Edited by Charles N. Reilley. (Interscience Publishers, New York), 1960. Pp. vii + 445. Price \$ 12.00.

Mechanism in Radiobiology, Vol. II: *Multicellular Organisms*. Edited by M. Errera and A. Forssberg. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xiii + 395. Price \$ 13.00.

Advances in Geophysics, Vol. 6: *International Symposium on Atmospheric Diffusion and Air Pollution*. Edited by F. N. Frenkiel and P. A. Sheppard. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xvii + 471. Price \$ 12.00.

Toxic Phosphorus Esters—Chemistry, Metabolism and Biological Effects. By Richard D. O'Brien. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xii + 434. Price \$ 14.50.

Organic Chemistry. By C. W. Wood and H. K. Holliday [Butterworth & Co. (Pub.) Ltd., London W.C. 2], 1960. Pp. xxii + 321. Price 21 sh.

Cytology and Evolution. By E. N. Willmer. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. x + 430. Price \$ 10.00.

Biological Activities of Steroids in Relation to Cancer. Edited by G. Pincus and E. P. Vollmer. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xvi + 530. Price \$ 15.00.

Symposium on Comparative Biology, Vol. I: *Comparative Biochemistry of Photoreactive Systems*. By M. B. Allen. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xii + 437. Price \$ 12.00.

Classical Electricity and Magnetism. By E. S. Shire. (Cambridge University Press, London N.W. 1), 1960. Pp. xvi + 396. Price 45 sh.

Inorganic Chemistry. By C. W. Wood and A. K. Holliday [Butterworth & Co. (Pub.) Ltd., London W.C. 2], 1960. Pp. viii + 393. Price 21 sh.

SCIENCE NOTES AND NEWS

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Physics to Miss P. R. K. L. Padmini for her thesis entitled "Ultrasonic studies in liquid states".

Karnatak University, Dharwar, has awarded the Ph.D. Degree in Physics to Messrs. V. M. Korwar and M. I. Savadatti for their theses entitled "Electronic Transition moment variation in aluminium oxide band system" and "Spectroscopic study of methyl alcohol flames" respectively.

Indian Society of Genetics and Plant Breeding

At the Twenty-first Annual Meeting of the Society held at Roorkee on January 3, 1961 the following Office-bearers were elected :

President—Dr. E. K. Janaki Ammal ; *Vice-Presidents*—Dr. A. R. Gopal Ayengar, Dr. A. B. Joshi ; *Secretary*—Dr. M. S. Swaminathan ; *Councillors*—Dr. S. M. Sikka, Dr. S. Govindaswamy, Prof. P. N. Bhaduri, Dr. B. S. Kadam, Shri G. P. Argikar, Dr. K. Ramiah ; *Editor*—Dr. B. P. Pal.

Rafi Ahmed Kidwai Memorial Prize

The First Rafi Ahmed Kidwai Memorial Prize for significant research in the field of Agricultural Botany was awarded in September 1960, to Dr. B. P. Pal, Director, Indian Agricultural Research Institute, New Delhi, for his outstanding contributions in the field of wheat breeding and genetics and for evolving the famous Pusa wheat varieties. This is one of the eleven prizes instituted by the Indian Council of Agricultural Research in 1958, to commemorate the memory of the late Shri Rafi Ahmed Kidwai, Union Minister of Food and Agriculture.

International Congress of Radiation Research

The Second International Congress of Radiation Research will be held at Harrogate, Yorkshire, England, August 5th to 11th, 1962. It is sponsored by a Committee set up at the First Congress at Burlington, Vermont, in 1958, and by the Association for Radiation Research. The programme will be concerned with the physical, chemical, biological and medical effects of radiations, particularly ionizing radiations. Research workers in these fields will be invited to proffer

original papers and reports of new experimental work. A brochure will be available in April 1961. Information may be obtained from Dr. Alma Howard, Secretary-General, the Second International Congress of Radiation Research, Mount Vernon Hospital, Northwood, Middlesex, England.

Sixth Congress on Theoretical and Applied Mechanics

The Indian Society of Theoretical and Applied Mechanics held their Sixth Congress in Delhi, on December 24-26, 1960. It was preceded by a one-day symposium on High Speed Computation Methods and Machines arranged by the Society jointly with the International Business Machines Corporation.

The half-hour addresses were delivered by R. Sauer (W. Germany), J. Kampe de Feriet (France), H. Zorski (Poland), H. B. Squire (England), H. Langhaar (U.S.A.) and G. N. Meshcheryakov (USSR). R. Sauer spoke on three-dimensional problems in gas dynamics and showed the application of characteristic grid methods to unsteady planar and steady spatial gas dynamic problems. J. Kampe de Feriet described the statistical mechanics of linearized plane sound waves in a perfect gas filling the whole space. H. Zorski gave a review of Polish papers and some new results on plates with discontinuous boundary conditions. H. B. Squire spoke on the theory of radial jet flows and described experimental work concerned with such flows. H. Langhaar gave an account of the general theory of stability of conservation system. G. N. Meshcheryakov spoke on the nature of self-excited vibration in metal-cutting processes.

In each of the two technical sessions on Fluid dynamics, and Elasticity and allied topics some twenty papers were presented and discussed. The next Congress will be held at the Indian Institute of Technology, Bombay, in December 1961.

I.C.A.R. Grant to *Current Science* for the Year 1959-60

The Current Science Association acknowledge with thanks the grant of subsidy of Rs. 3,000 for the year 1959-60 from the Indian Council of Agricultural Research, towards printing of *Current Science*.

alternative picture which avoided the necessity for a single moment of "creation" and which did not involve any large-scale changes in the universe. According to this view, the universe was everlasting, and, in order to explain the recession of galaxies, they suggested that new matter was being continually created everywhere throughout space and that this matter condensed to form new galaxies to replace those lost to view as the expansion continued.

The possibilities of distinguishing between these two pictures has been a major theme in the programme of the great optical telescope. In the "steady state" model, the density of the galaxies would have been just the same in the past as it is now. In the evolving, or "explosion"; model, on the other hand, the density is getting progressively less.

We cannot observe nearby galaxies for long enough to detect any change in their density but, since light from the most distant galaxies has taken some thousands of millions of years to reach the earth, observers, in effect, see them as they were that time ago. Thus we can compare distant and nearby regions of space and look for differences both in density and constitution. On the explosion model, distant galaxies will appear to an observer younger than nearby ones, while on the steady-state model each

volume of space will contain a mixture of young and old galaxies.

The new science of radio-astronomy has made it possible to probe deeper and deeper into space—possibly to distances of 8,000 million light-years, or four-fifths of the observable limits of the universe, because at distance of about 10,000 million light-years the speed of recession of the galaxies exceeds that of light, and neither light nor radiowaves from them can reach the earth.

Investigations, therefore, have been carried much further than was hitherto possible by optical means, and the conclusion reached by Professor Ryle and his associates is that the steady-state model cannot represent the actual universe. It is observed that radio-emitting galaxies are more densely distributed in the most distant parts of the universe than at lesser distances.

Steady-state protagonists are by no means convinced, however, and Professor Fred Hoyle, Professor of Astronomy at Cambridge, has said that much more work would be necessary, and that before he could accept the evolutionary theory it would have to be shown that no new galaxies were forming.—(British Information Service.)

Particulars of *Current Science*—The Monthly Science News Journal of India—as per Form IV under Rule 8 of the Registration of Newspapers (Central) 1956.

1. Place of Publication : Bangalore.
2. Periodicity of Publication : 26th of each month.
3. Printer's Name, Nationality and Address : Sri. T. K. Balakrishnan, Indian, Superintendent, Bangalore Press, Bangalore-18.
4. Publisher's Name, Nationality and Address : Sri. A. V. Telang, Indian, Secretary, Current Science Association, Bangalore-6.

I, A. V. Telang, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Bangalore-6,
March 26, 1961.

(Sd.) A. V. TELANG.
Publisher, *Current Science*.

50 61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc. should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

STRUCTURE OF COLLAGEN

G. N. RAMACHANDRAN AND V. SASISEKHARAN

Department of Physics, University of Madras, Madras-25

A TRIPLE helical structure for collagen was proposed from this laboratory more than six years ago.¹ This consisted of three polypeptide chains, each having a three-fold screw symmetry (3_2 for L-type residues) which were linked together by hydrogen bonds approximately perpendicular to the length of the chains. A very satisfactory feature of this structure was that every third residue in it must necessarily be a glycyl residue, for there was no space in it for a side group (or even the β -carbon atom) to be attached to the corresponding α -carbon atom. This particular feature, namely, that 33% of the residues are glycyl, is universally true of collagen from different sources. The structure could readily accommodate proline and hydroxyproline residues (the latter in particular being known to be characteristic of collagen alone), besides being in agreement with the infra-red dichroism and other properties of collagen.

It soon became apparent that, although the structure was basically correct, the details required modification, for an analysis of the X-ray pattern of stretched collagen² indicated that the number of residues per turn in collagen is nearly $3\frac{1}{3}$ and not 3. The presence of such a non-integral number of residues per turn required that the three chains must all be further coiled around. Consequently, a coiled coil structure was put forward for collagen, which retained the essential features of the earlier one.³ The structure was made to have as many hydrogen bonds as possible, namely, two hydrogen bonds for every three residues, although this led to some short contacts.

This structure has however been criticized because of the occurrence of these few short contacts⁴ and it has been suggested that only structures with one hydrogen bond for every three residues can be built up which are free of short contacts. It appears to be generally taken for granted following the above-mentioned criticism of Rich and Crick⁴ that a two-bonded structure is impossible for collagen. But, as stated by Ramachandran,⁵ such an one-bonded structure is really unsatisfactory as a set of hydrogen bonds are not formed and a number of imino hydrogens are systematically left unbonded. It is possible, however, that these hydrogens may take part in bonding through a water molecule, but a careful study is required

of this question, and such a bond need be postulated only if a direct hydrogen bond is impossible.

The whole question has been re-examined recently in this laboratory, and it has been found that it is not impossible to bring the short contacts to permissible values while still retaining the two hydrogen bonds. The purpose of this communication is to show that a structure with two hydrogen bonds for every three residues is a possible one and is consistent with the physical and chemical properties of collagen.

Such a structure became possible essentially because a close study made in this laboratory of the available data on various organic structures showed that the exigencies of the situation in several cases may demand (interatomic) contact distances much shorter than the sum of the corresponding van der Waals' radii. Many examples can be cited in which the contact distances are much shorter than the criteria stated by Rich and Crick in their paper⁴ (viz., C....C = 3.6 to 4.0 Å and C....O = 3.2 to 3.5 Å). Thus an examination of the reported crystal structures shows that not only are C....C distances of the order of 3.2 Å (the value found in our earlier structure) observed in a number of cases, but that they can even be smaller, down to 2.9 Å. So also C....O contacts are found to be less than 3.1 Å in a number of cases and values down to 2.7 Å have been reported. Also, if Rich and Crick's criteria were adopted, some of the known structures, for example the α -helix, would be unacceptable. (The full data will be given in a detailed publication.)

The other criticism that has been made is that the two-bonded structure (two hydrogen bonds for every three residues) cannot accommodate the sequence gly-pro-hydroxy, which appears to be of frequent occurrence in hydrolysates of collagen, for at the second α -carbon atom, there is no NH now to be hydrogen bonded. However, this does not mean that one must switch over from a two-bonded to a completely one-bonded structure. It is obvious that in those regions where proline does not occur, a structure in which the imino group is bonded is preferable to one in which it is not. In our latest approach both hydrogen bonds are made, but where the sequence gly-pro-hydroxy occurs, the residues slightly rotate around to accommodate these side-chains.

alternative picture which avoided the necessity for a single moment of "creation" and which did not involve any large-scale changes in the universe. According to this view, the universe was everlasting, and, in order to explain the recession of galaxies, they suggested that new matter was being continually created everywhere throughout space and that this matter condensed to form new galaxies to replace those lost to view as the expansion continued.

The possibilities of distinguishing between these two pictures has been a major theme in the programme of the great optical telescope. In the "steady state" model, the density of the galaxies would have been just the same in the past as it is now. In the evolving, or "explosion", model, on the other hand, the density is getting progressively less.

We cannot observe nearby galaxies for long enough to detect any change in their density but, since light from the most distant galaxies has taken some thousands of millions of years to reach the earth, observers, in effect, see them as they were that time ago. Thus we can compare distant and nearby regions of space and look for differences both in density and constitution. On the explosion model, distant galaxies will appear to an observer younger than nearby ones, while on the steady-state model each

volume of space will contain a mixture of young and old galaxies.

The new science of radio-astronomy has made it possible to probe deeper and deeper into space—possibly to distances of 8,000 million light-years, or four-fifths of the observable limits of the universe, because at distance of about 10,000 million light-years the speed of recession of the galaxies exceeds that of light, and neither light nor radiowaves from them can reach the earth.

Investigations, therefore, have been carried much further than was hitherto possible by optical means, and the conclusion reached by Professor Ryle and his associates is that the steady-state model cannot represent the actual universe. It is observed that radio-emitting galaxies are more densely distributed in the most distant parts of the universe than at lesser distances.

Steady-state protagonists are by no means convinced, however, and Professor Fred Hoyle, Professor of Astronomy at Cambridge, has said that much more work would be necessary, and that before he could accept the evolutionary theory it would have to be shown that no new galaxies were forming.—(British Information Service.)

Particulars of Current Science—The Monthly Science News Journal of India—as per Form IV under Rule 8 of the Registration of Newspapers (Central) 1956.

1. Place of Publication : Bangalore.
2. Periodicity of Publication : 26th of each month.
3. Printer's Name, Nationality and Address : Sri. T. K. Balakrishnan, Indian, Superintendent, Bangalore Press, Bangalore-18.
4. Publisher's Name, Nationality and Address : Sri. A. V. Telang, Indian, Secretary, Current Science Association, Bangalore-6.
5. Editor's Name, Nationality and Address : Dr. A. S. Ganesan, Indian, Editor, Current Science, Bangalore-6.
6. Manager's Name, Nationality and Address : Sri. S. R. S. Sastry, Indian, Manager, Current Science Association, Bangalore-6.
7. Name and Address of the Individual who owns the Paper : The Current Science Association, Bangalore-6.

I, A. V. Telang, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Bangalore-6,
March 26, 1961.

(Sd.) A. V. TELANG.
Publisher, Current Science.

50 61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, Current Science, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

STRUCTURE OF COLLAGEN

G. N. RAMACHANDRAN AND V. SASISEKHARAN

Department of Physics, University of Madras, Madras-25

A TRIPLE helical structure for collagen was proposed from this laboratory more than six years ago.¹ This consisted of three polypeptide chains, each having a three-fold screw symmetry (3_2 for L-type residues) which were linked together by hydrogen bonds approximately perpendicular to the length of the chains. A very satisfactory feature of this structure was that every third residue in it must necessarily be a glycyl residue, for there was no space in it for a side group (or even the β -carbon atom) to be attached to the corresponding α -carbon atom. This particular feature, namely, that 33% of the residues are glycyl, is universally true of collagen from different sources. The structure could readily accommodate proline and hydroxyproline residues (the latter in particular being known to be characteristic of collagen alone), besides being in agreement with the infra-red dichroism and other properties of collagen.

It soon became apparent that, although the structure was basically correct, the details required modification, for an analysis of the X-ray pattern of stretched collagen² indicated that the number of residues per turn in collagen is nearly $3\frac{1}{3}$ and not 3. The presence of such a non-integral number of residues per turn required that the three chains must all be further coiled around. Consequently, a coiled coil structure was put forward for collagen, which retained the essential features of the earlier one.³ The structure was made to have as many hydrogen bonds as possible, namely, two hydrogen bonds for every three residues, although this led to some short contacts.

This structure has however been criticized because of the occurrence of these few short contacts⁴ and it has been suggested that only structures with one hydrogen bond for every three residues can be built up which are free of short contacts. It appears to be generally taken for granted following the above-mentioned criticism of Rich and Crick⁴ that a two-bonded structure is impossible for collagen. But, as stated by Ramachandran,⁵ such an one-bonded structure is really unsatisfactory as a set of hydrogen bonds are not formed and a number of imino hydrogens are systematically left unbonded. It is possible, however, that these hydrogens may take part in bonding through a water molecule, but a careful study is required

of this question, and such a bond need be postulated only if a direct hydrogen bond is impossible.

The whole question has been re-examined recently in this laboratory, and it has been found that it is not impossible to bring the short contacts to permissible values while still retaining the two hydrogen bonds. The purpose of this communication is to show that a structure with two hydrogen bonds for every three residues is a possible one and is consistent with the physical and chemical properties of collagen.

Such a structure became possible essentially because a close study made in this laboratory of the available data on various organic structures showed that the exigencies of the situation in several cases may demand (interatomic) contact distances much shorter than the sum of the corresponding van der Waals' radii. Many examples can be cited in which the contact distances are much shorter than the criteria stated by Rich and Crick in their paper⁴ (*viz.*, C...C = 3.6 to 4.0 Å and C...O = 3.2 to 3.5 Å). Thus an examination of the reported crystal structures shows that not only are C...C distances of the order of 3.2 Å (the value found in our earlier structure) observed in a number of cases, but that they can even be smaller, down to 2.9 Å. So also C...O contacts are found to be less than 3.1 Å in a number of cases and values down to 2.7 Å have been reported. Also, if Rich and Crick's criteria were adopted, some of the known structures, for example the α -helix, would be unacceptable. (The full data will be given in a detailed publication.)

The other criticism that has been made is that the two-bonded structure (two hydrogen bonds for every three residues) cannot accommodate the sequence gly-pro-hydro, which appears to be of frequent occurrence in hydrolysates of collagen, for at the second α -carbon atom, there is no NH now to be hydrogen bonded. However, this does not mean that one must switch over from a two-bonded to a completely one-bonded structure. It is obvious that in those regions where proline does not occur, a structure in which the imino group is bonded is preferable to one in which it is not. In our latest approach both hydrogen bonds are made, but where the sequence gly-pro-hydro occurs, the residues slightly rotate around to accommodate these side-chains.

Another factor which helped in working out a satisfactory two-bonded structure is that an examination of the known structures of amino-acids and peptides revealed appreciable deviations either from planarity of the peptide group or from the standard bond lengths and bond angles in the group in almost every case. Obviously, such variations occur because the situation demands it, e.g., some hydrogen bond is made shorter or more straight thereby, or somewhere a short contact is relieved. This suggests that provided the structure proposed has values for the bond distances and angles within the observed range in various known crystal structures, it should be considered satisfactory. In the latest structure, whose co-ordinates are given below, small deviations of the peptide groups from planarity occur, but the bond lengths and angles are all well within the normally observed range.

Another interesting factor revealed by a survey of the literature which helped in working out the two-bonded structure was that the hydrogen bond distance from an amide NH to a carbonyl oxygen ($O = C$) is invariably larger than 2.9 Å. It is found that for hydrogen bond distances lying between 3.0–3.05 Å, the infra-red frequency is about $3,350 \text{ cm}^{-1}$ which is nearly the same as found in collagen (actually for collagen it is close to $3,330 \text{ cm}^{-1}$). This is rather important, since it is found very difficult to reduce the bond lengths to less than 3.0 Å in the two-bonded structure. On the other hand, it is, in the one-bonded structure, rather difficult to increase the bond length to greater than 2.85 Å if the condition that every third residue should be glycine is assumed. Thus infra-red data show that most of the hydrogen bonds in collagen are weaker than in other proteins and polypeptides and this is in good agreement with the two-bonded structure.

One of the main results of our present study is that, while the two-bonded structure is highly specific and can only occur for helical parameters close to what are actually found in collagen, the one-bonded structure can occur over a very wide range of configurations. Also, a fact which seems to have been overlooked previously is that there is no reason why the exact rational value $10/3$ should occur for the number of residues per turn (n) in the minor helix. In view of this, following Ramachandran's paper,⁶ careful measurements were made on X-ray patterns of both natural and stretched collagen and these showed that the value of n is close to 3.28 and not 3.33 ($10/3$), i.e., the twist for three residues t is only about

30° and not 36° , as has been assumed so far. In addition it was also found that the residue height h for unstretched collagen is 2.95 Å rather than 2.86 Å. These values, viz., $h = 2.95 \text{ Å}$, $n = 3.28$, $t = 30^\circ$ should replace the older values $h = 2.86 \text{ Å}$, $n = 3.33$, $t = 36^\circ$.

These changes are really significant from the point of view of the stereochemistry of the structure, for it is actually found that a two-bonded structure based on the new values is superior to the one based on the old values with respect to short contacts and hydrogen bond angles.

A projection of the new two-bonded structure, the so-called standard structure, arrived at after a careful study, is shown in Fig. 1 and the co-

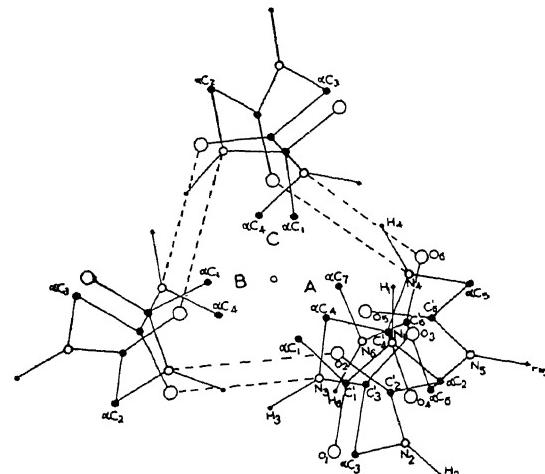


FIG. 1. Projection of the standard structure of collagen along the fibre axis. The two hydrogen bonds, for every three residues are shown by dotted lines.

ordinates are given in Table I. The interatomic distances and bond angles for this structure are not significantly different from the Pauling-Corey parameters. The two hydrogen bond lengths, viz., N_1H_1 (B) ... O_2 (A) = 3.00 Å and N_3H_3 (A) ... O (B) = 3.05 Å are agreeing well with the infra-red data and the angle between NH and NO is less than 30° for both the bonds. The only short contacts found in the structure are (1) O_2 (A) ... O_3 (A) = 2.73 Å, (2) C_1 (B) ... O_2 (A) = 2.90 Å, (3) C_1 (A) ... O_2 (B) = 3.10 Å, (4) C_4 (A) ... O_3 (B) = 3.03 Å, and (5) C_1 (A) ... C_1 (B) = 3.50 Å. The structure is thus seen to be satisfactory in every respect.

The satisfactory nature of this structure explains the occurrence of $h = 2.95 \text{ Å}$ in natural collagen which is found to be remarkably constant in specimens from a wide variety of sources.

TABLE I

Atomic co-ordinates of the atoms in one set of three residues of the proposed structure of collagen. The cylindrical polar co-ordinates given are with respect to the axis of the major helix

Atom	<i>r</i> (A)	(°)	<i>z</i> (A)
C ₁	1.15	0.0	0.00
C ₂	2.27	12.0	1.00
O ₁	3.26	-3.6	1.15
N ₁	2.43	38.8	1.70
H ₁	2.15	63.1	1.71
C _{2'}	3.52	35.4	2.72
C _{2''}	2.93	23.0	3.96
O ₂	1.75	17.5	4.16
N ₂	3.79	15.8	4.82
H ₂	4.78	18.1	4.70
C ₃	3.47	2.0	6.00
C _{3'}	2.50	18.7	6.86
O ₃	2.68	45.5	6.50
N ₃	1.95	1.8	7.87
H ₃	2.29	-24.4	8.04
C ₄	1.15	30.0	8.85

So also attempts were made to build structures corresponding to twists *t* of 10° and 50° for three residues keeping *h* = 2.95 Å, but these were distinctly bad since one of the hydrogen bonds became very long when short contacts were avoided. This explains why collagen forms a coiled coil structure, and also why the coiling corresponds to a twist close to 30° for three residues.

On the other hand for an one-bonded structure which can occur over a very wide range of configurations, no coiled coiling is needed and the residue height can also vary. It is not specific and it cannot explain why collagen has the parameters for its structure which are actually found.

Thus, in short, the two-bonded structure could explain several of the observed facts about collagen such as

(a) The observed height of about 2.95 Å per residue along the fibre axis and its relative inextensibility; (b) the occurrence of a coiled coil instead of a simple triple chain and the actual magnitude of the second coiling and

TABLE II

The co-ordinates of the atoms in a set of three residues of the three chains A, B₁ and B₂ of the structure of collagen. For the chain A which accommodates the sequence gly-pro-hydroxyproline, the co-ordinates of the side chain atoms of the proline and hydroxyproline residues are also given. The co-ordinates given are with respect to the axis of the major helix

Atom	<i>r</i> (A)	(°)	<i>z</i> (A)	Atom	<i>r</i> (A)	(°)	<i>z</i> (A)
<i>Chain A</i>							
αC ₋₂	..	1.15	80.0	-2.95	C' ₂	..	2.93
C' ₋₂	..	2.19	84.7	-1.83	O ₂	..	1.75
O ₋₂	..	2.90	64.8	-1.38	N ₂	..	3.79
N ₋₂	..	2.69	112.0	-1.41	H ₂	..	4.78
δC ₋₂	..	3.12	139.1	-1.81	αC ₃	..	3.47
γC ₋₂	..	4.58	136.9	-1.37	C' ₃	..	2.50
βC ₋₂	..	4.65	125.5	-0.14	O ₃	..	2.68
αC ₋₁	..	3.71	109.1	-0.33	N ₃	..	1.95
C' ₋₁	..	2.99	99.4	0.89	H ₃	..	2.29
O ₋₁	..	1.77	97.8	1.05	αC ₄	..	1.15
N ₋₁	..	3.83	93.5	1.83	<i>Chain B₁—(Contd.)</i>		
δC ₋₁	..	5.28	95.2	1.80	C' ₂	..	3.47
γC ₋₁	..	5.87	85.0	2.78	O ₂	..	2.50
O _H	..	6.28	72.8	2.09	N ₀	..	2.63
βC ₋₁	..	4.90	81.0	3.78	H ₀	..	1.95
αC ₀	..	3.46	82.0	3.05	αC ₁	..	2.29
C' ₀	..	2.50	88.7	3.91	..	1.15	-110.0
O ₀	..	2.68	125.5	3.55	C' ₁	..	2.27
N ₀	..	1.95	81.8	4.92	O ₁	..	3.26
H ₀	..	2.29	55.6	5.09	N ₁	..	2.43
αC ₁	..	1.15	110.0	5.90	H ₁	..	2.15
<i>Chain B₁</i>							
βC ₁	..	1.15	0.0	0.00	αC ₂	..	3.52
C' ₁	..	2.27	12.0	1.00	C' ₂	..	2.93
O ₁	..	3.26	-3.6	1.15	O ₂	..	1.74
N ₁	..	2.43	38.8	1.70	N ₂	..	3.78
H ₁	..	2.15	63.1	1.71	H ₂	..	4.76
αC ₂	..	3.52	35.4	2.72	αC ₃	..	3.47

(c) the occurrence of 33% of glycine and a large proportion of proline and hydroxyproline.

The one-bonded structure cannot explain any of these properties except (c) since a wide range is possible for it. The infra-red data also completely support the occurrence of long hydrogen bonds 3.0-3.05 Å, found in the two-bonded structure.

Even when the sequence gly-pro-hydroxy occurs in one of the three chains, or locally in all the three chains, the standard structure can be slightly modified to incorporate these. The co-ordinates of the atoms in the three chains in the former case are given in Table II and the structure is shown in Fig. 2. Five hydrogen

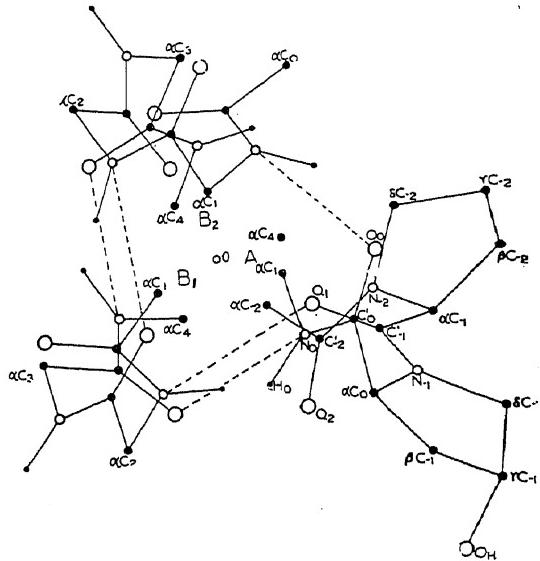


FIG. 2. Projection along the fibre axis of the structure of collagen with five hydrogen bonds for nine residues. For the chain 'A' which accommodates the sequence gly-pro-hydroxy, the positions of all the atoms of the proline and hydroxyproline residues in the projection are also shown.

bonds are formed for every nine residues. The atoms in two backbones of the chains are practically in the same positions as in the standard structure, while in the third chain none of them are displaced by more than 0.5 Å. If all the

three chains have the sequence gly-pro-hydroxy, then only an one-bonded structure is possible, but even in this case, the shifts of individual atoms are less than 0.5 Å.

Finally it may be mentioned that the calculated Fourier transform (F.T.) of the standard two-bonded structure is in good agreement with observation. Also, the two-bonded structure is distinctly in better agreement with the observed X-ray pattern than the one-bonded structure. Thus, its F.T. has a broad belt of intensity centred at $\xi = 0.35$, as actually observed, while this belt is distinctly nearer the meridian ($\xi = 0.30$) for the one-bonded structure. So also, the first maximum on the third layer is much stronger with the two-bonded structure, as actually observed. The position of the first maximum on the fourth layer is closer to the meridian for the two-bonded structure and occurs close to the observed position. In the sixth layer, there is a clear maximum in the F.T. at $\xi = 0.66$, as observed for this structure, while there is no such maximum in the F.T. of the one-bonded structure. Lastly, the strong blob of intensity observed on the equator corresponding to $d = 4.4$ Å is explained by the occurrence of nearly parallel planar residues in the backbones of neighbouring chains at this distance apart. The corresponding distance in the one-bonded structure is 4.8 to 4.9 Å, and does not agree with observation.

Details of these studies are given in a series of papers in the Report of the Collagen Symposium held at Madras in November 1960 (under publication). We wish to acknowledge the assistance of Messrs. Y. T. Thathachari, B. R. Lakshmanan and C. Ramakrishnan in part of this work.

1. Ramachandran, G. N. and Kartha, G., *Nature*, 1954, **174**, 269.
2. — and Ambady, G. K., *Curr. Sci.*, 1954, **23**, 345.
3. — and Kartha, G., *Proc. Ind. Acad. Sci.*, 1959, **42 A**, 215.
4. Crick, F. H. C. and Rich, A., *Nature*, 1955, **176**, 915.
5. Ramachandran, G. N., *Ibid.*, 1956, **177**, 710.
6. — *Proc. Ind. Acad. Sci.*, 1960, **52 A**, 240.

LONG WAVELENGTH SPECTRUM OF SOLAR CORONA

A SPECTRUM of the solar corona in the near infra-red region 1μ , was obtained by the staff members of the Sternberg Institute of Astronomy, USSR, during the solar eclipse of February 15, 1961. A detailed study of the emission line of wavelength 1.0747 micron (10747 Å) has been made in this region. This

line is emitted by strongly ionized atoms of iron which have 12 electrons knocked out of them under extremely high temperature. It is reported that the obtained information warrants definite conclusions concerning the physical conditions of matter in the outer envelope of the solar atmosphere.—(USSR News).

MORPHOGENETIC RESPONSES OF THE THALLUS OF *MARCHANTIA* TO SEVERAL GROWTH SUBSTANCES

K. N. KAUL, G. C. MITRA AND B. K. TRIPATHI

Tissue Culture Laboratory, National Botanic Gardens, Lucknow, India

DURING recent investigations on the reactivity of young developing thalli of *Marchantia nepalensis* L. et L. to several growth substances we found that the different organs of the thallus responded differently to different growth substances.

Aseptic cultures were prepared from young thalli of about 1.0 cm. in length as inocula on a standard Knop's nutrient solution with the addition of three concentrations, namely, 1.0, 0.1 and 0.01 mg./l. of Indoleacetic acid (IAA), Indolebutyric acid (IBA), Indolepropionic acid (IPA), α -Naphthaleneacetic acid (NAA), Naphthoxyacetic acid (NOA), 2, 4-Dichlorophenoxyacetic acid (2, 4-D), Maleic hydrazide (MH), 2:4:5: Trichlorophenoxyacetic acid (TCPA), 2:3:5: Triiodobenzoic acid (TIBA), and 2, 4-Dinitrophenol (2, 4-DNP). Both solid and liquid cultures were grown under artificial light from fluorescent tubes (Natural) giving 2,600-3,000 lux of 17 hours duration in 24 hours cycle at the level of the cultures. The temperature was regulated at 24°-25°C.

The most striking effects may be summarized as follows :

(a) Highest concentration (1.0 mg./l.) of NOA, 2, 4-D, TCPA, IPA, IAA and IBA and 0.1 mg./l. of NAA stimulated rhizoid formation and inhibited thallus growth but NAA in its highest concn. was inhibitory to rhizoid formation. Furthermore NAA, NOA and TCPA induced rhizoid formation not only on ventral but also on dorsal surfaces of thalli extending up to their apical regions. The latter substances including 2, 4-D in their lowest concn. (0.01 mg./l.) was even inhibitory to thallus growth.

Highest concn. of MH, TIBA and 2, 4-DNP neither stimulated nor inhibited rhizoid formation and thallus growth and even their lower concns. (0.1 and 0.01 mg./l.) were not stimulatory to either rhizoid formation or to thallus growth.

(b) Highest concn. of NAA, NOA, TCPA and 2, 4-D produced globular masses of callus-like tissue on inoculated thalli. The globular masses were mostly yellowish-brown or brown in colour except those produced by TCPA which were green. Even at a later period of growth the globular masses did not differentiate into thalli but they did so on being transferred to

control media. However, these differentiated thalli did not attain normal size (Fig. 1 A).

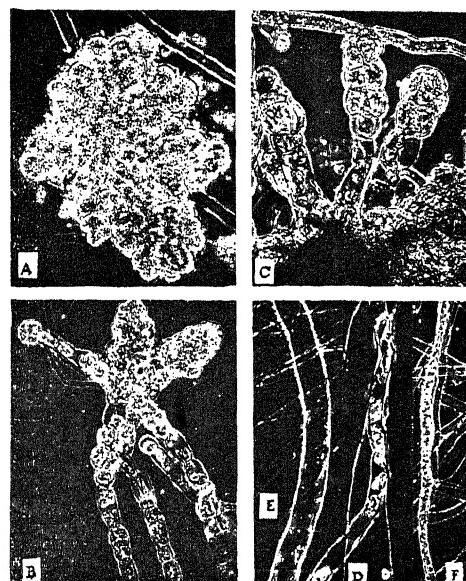


FIG. 1. *Marchantia nepalensis*. A, Callus-like growth, $\times 75$; B and C, filamentous growth terminated by differentiating thalli—B $\times 55$, C, $\times 90$; D, A tuberculated rhizoid ($\times 140$) showing pegs in its distal region but not in its terminal portion; E, Tip region of the tuberculated rhizoid shown in D, $\times 140$; F, a tube-enclosed rhizoid ($\times 50$) showing prominent pegs.

(c) Highest concn. of IAA, IBA, IPA, TIBA and 2, 4-DNP produced globular masses of callus-like tissue on inoculated thalli at an earlier period of growth but at a later period these masses differentiated into new thalli. Whereas highest concn. of MH and TIBA produced new thalli directly from inoculated thalli.

Commonly new thalli were minute and brittle in liquid cultures.

(d) New thalli developed in three ways:

(i) directly from cells of inoculated thalli commonly from their distal regions; (ii) from cells of globular masses; and (iii) from filamentous growth of cells of inoculated thalli and of globular masses (Fig. 1 B, C).

(e) All the concns. of IPA, TIBA, 2, 4-D and 2, 4-DNP inhibited typical tuberculate rhizoid formation in their liquid but not in their solid cultures; but only in one case, that of 1.0 mg./l.

NAA, tuberculate rhizoids were not formed in liquid as well as in solid cultures.

Pegs of tuberculate rhizoids were poorly developed in liquid cultures containing 1·0 and 0·1 mg./l. of TCPA, IAA, NOA and IBA and even in control liquid cultures (Fig. 1 D, E, F).

(f) Highest concn. of NAA, NOA, TCPA and 2, 4-D and 0·1 mg./l. TCPA inhibited gemma-cup formation in solid as well as in their liquid cultures.

Highest concn. of IPA, IBA and TIBA and 0·1 mg./l. NOA inhibited gemma-cup formation in their solid cultures only. In solid cultures gemma-cups were formed mostly in submerged thalli but very rarely in aerial ones.

Gemma-cup formation was markedly pronounced especially in liquid cultures containing 2, 4-DNP and TIBA.

(g) Germinated gemmæ with smooth rhizoids were found within gemma-cups in cultures containing MH, NAA, NOA, 2, 4-D and 2, 4-DNP and also in control cultures.

Germinated gemmæ without rhizoids were found within gemma-cups in cultures containing MH, NAA, NOA, 2, 4-D and 2, 4-DNP and also in control cultures.

It is evident from the observations mentioned above that rhizoids and thalli of *Marchantia nepalensis* like roots and shoot-buds of higher plants responded in a similar way to stimulatory and inhibitory effects of higher and lower concns. of auxins and antiauxins used. It may thus be envisaged that there exists a basic biochemical pattern common to roots and shoot-buds of higher plants and rhizoids and thalli of *M. nepalensis* indicating homologies in organization. In higher plants this basic biochemical pattern has further been elaborated during evolution giving rise to more complex organizations like roots and shoot-buds.

The antiauxins like MH, TIBA and 2, 4-DNP are well known for their peculiar effects in higher plants but they have not produced any such effects in the highest concn. used in this experiment. It is to be seen whether they can produce any morphogenetic response in still higher concns.

Allsopp¹ obtained callus-like tissue in *Fossombronia pusilla* (L.) Dunn. and *Reboulia hemispherica* (L.) Raddi. in cultures containing glucose. In the present experiment globular masses produced by certain auxins and antiauxins mentioned previously are similar undifferentiated callus-like tissue which begins to differentiate when transferred to nutrient media without the growth substances. According to Bünning^{2,3} polarity is of decisive importance for

all the processes of differentiation, and suppression of polarity by direct effects of physical or chemical factors on the protoplasm, will prevent normal differentiation but may allow cell division to continue. On the basis of this hypothesis, the action of these growth substances on young developing thalli could be due to their direct effect on the internal gradients of chemicals.

Regeneration of thalli directly from cells of inoculated thalli or from filamentous growth of cells of inoculated thalli or of globular masses throws light on the debated problem of the existence of hepaticas. Various lengths of filamentous growth observed in the present experiment prior to the differentiation of a normal thallus from a two-sided apical cell indicate that the filamentous growth results from induction of successive transverse divisions in the thallus initial by different growth substances for a variable duration. Similar prolongation of thallus initials into filamentous growth prior to differentiation by a physical factor like unilateral or weak illumination has been reported by Goebel,⁴ Pande,⁵ Mehra and Kachroo⁶ and others in other hepaticas. This filamentous growth is not comparable to protonemal growth of mosses where it is a distinct and a constant phase of the gametophyte. These experimental evidences support Campbell's⁷ conclusion on this issue.

Inhibition of tuberculate rhizoids and not of smooth ones by certain growth substances and the formation of tuberculate rhizoids with various degrees of poorly developed pegs in cultures containing certain growth substances bring out that the two types of rhizoids are not only morphologically but also physiologically different. This point is emphasized by the occurrence in cultures of certain tuberculate rhizoids whose distal regions are with poorly developed pegs but their terminal regions are without them. Furthermore the presence of poorly developed pegs in tuberculate rhizoids of control liquid and not of control solid cultures indicates that the hydration of the colloidal constituents of the cell may have affected synthesis of peg-substance which seems to be pecto-cellulose on micro-chemical tests. Synthesis of peg-substance was completely inhibited in liquid but not in solid cultures containing certain growth substances as mentioned previously. This finding tends to help in the understanding of the speculated functions of the two types of rhizoids of the Marchantiaceae. We are also well aware of the morphogenetic effects of water in higher plants as well expressed by the phenomenon of heterophyly and the production of

land and water forms of certain amphibious plants.

LaRue and Narayanaswami⁸ state that the gemmæ of liverworts do not germinate within gemma-cups unless they have been detached from the parent body. Audus⁹ suggests that "in this the controlling agent may be a specific inhibitor produced by the parent tissue". In the present experimental conditions germinated gemmæ with or without rhizoids have been found within gemma-cups in control cultures as well as in cultures containing certain growth substances. It is also interesting to note that certain growth substances have inhibited the formation of gemma-cups. The findings also indicate that production of gemma-cups is conditioned by good humid conditions.

These observations will be considered in greater detail elsewhere.

1. Allsopp, A., *Nature* (Lond.), 1957, **179**, 681.
2. Bünning, E., *Surv. Biol. Progs.*, 1952, **2**, 105.
3. ———, *The Growth of Leaves*, Ed. F. L. Milthorpe, London, 1956.
4. Goebel, K., *Organography of Plants* (Eng. Ed., Pt. I), 1900.
5. Pande, S. K., *Jour. Indian Bot. Soc.*, 1924, **4**, 117.
6. Mehra, P. N. and Kachroo, P., *The Bryoz.*, 1951, **54**, 1.
7. Campbell, D. H., *The Structure and Development of Mosses and Ferns*, New York, 1918.
8. LaRue, C. D. and Narayanaswamy, S., *The New Phytol.*, 1957, **56**, 1.
9. Audus, L. J., *Plant Growth Substances*, London 1959.

RESEARCH INTO BOILER CIRCULATION THEORY

A REPORT on an extensive series of experimental investigations of the fundamental factors influencing the circulation process in high pressure boilers was presented to a meeting of the Institution of Mechanical Engineers in London, on 29th March 1961, by Haywood, Knights, Middleton and Thom.

The research project was sponsored by the Water-Tube Boilermakers' Association and was carried out by the authors at Cambridge. The primary object of the research was to establish experimental data relating to the flow conditions and pressure drop of high pressure steam-water mixtures flowing along heated and unheated pipes—in both horizontal and vertical positions. Simple boiler circulation theory is based on the assumption that the steam-water mixture moves as a homogeneous fluid, but there was little existing data on effects of relative velocity between the steam and water phases, a phenomenon which was known to exist under actual flow conditions in a boiler circuit. The paper describes an isotopic technique of determining this relative velocity of the two phases.

This consists in measuring the absorption of gamma-rays in their passage through the two-phase mixture at the outlet from the test section. The results from the gamma-ray equipment—in which the beam was provided by a radioactive isotope of caesium—enabled calculations to be made of the apparent density of the fluid mixture, and consequently the respective velocities of the two phases at that point. Preliminary tests involving scans along a number of chords of the tube cross-section showed that the density distribution of the fluid

was different with horizontal and vertical pipes. The data thus obtained from these and other tests were used to calculate slip correction factors, by means of which the acceleration and gravitational pressure drops—calculated according to homogeneous theory—could be corrected for the effects of slip. The paper presents an analysis of the pressure drop measurements made on the 1-inch and 1½-inch bore pipes in the vertical and horizontal positions, with particular attention to the frictional pressure drops in the horizontal pipes.

In their conclusions the authors state that, over the range of variables covered in the tests, the experimental pressure drops at 2,100 p.s.i. abs. are close to the values predicted by homogeneous theory for both horizontal and vertical pipes. For horizontal pipes at the lower pressure, homogeneous theory gives closer prediction of the pressure drop for heated than for unheated pipes, owing to the opposing effects of two-phase flow conditions on the frictional and acceleration pressure drops in the heated pipes. For vertical pipes at the lower pressures, the experimental pressure drops are significantly greater than the values predicted by homogeneous theory. The gravitational contribution to the total pressure drop is dominant, and it is influenced significantly by the effects of slip.

The results of the work have provided a wealth of information in a field in which there has been previously a scarcity of reliable data.—(Courtesy: The Water-Tube Boilermakers' Association, 8 Waterloo Place, London, S.W. 1).

SOME NEW CONCEPTS IN NON-LINEAR SYSTEMS

C. LAKSHMI-BAI*

Of late active interest has been displayed in the general field of non-linear systems and various techniques have been developed to analyse different aspects of the system under investigation. A technique developed by the author giving a new perspective and greater insight into the physical significance of the response of non-linear systems is presented in this communication.

Its principal features, and the major conclusions arrived at, are indicated in brief.

The behaviour of many complex physical systems is governed by higher-order non-linear differential equations. The solution of such equations is closely related to the number and nature of roots of the associated linear differential equation. The solution of the governing equation itself, is here obtained by the principle of the variation of parameters. It has been recognized that any non-linear system can be easily portrayed by a simple mathematical representation by means of a 'response-vector' and an orthogonal frame of reference. This reference-frame can have its directions along the inphase, quadrature and zero-phase components, with reference to the phase of the assumed solution. Thus, it can be easily visualized that the response-vector belongs to a space of as many dimensions as the order of the original governing equation; and, that it can be resolved into components along the above-referred directions of remarkable physical significance. These can be suitably denoted by the term 'space-phase components'.

One of the important features of the mathematical representation is that cross-harmonic terms are no longer present, yet the non-linear behaviour has been adequately accounted for by the d.c. and first harmonic terms. Thus it can be significantly referred to as the 'transient system-equivalent'. Such a representation can take care of the different types of inputs along with specified initial conditions. Thus it can reveal valuable information about peak overshoot, time of rise, time of settling, as well as possible limit-cycle behaviour. Though geometric representation is possible only for first, second and third order systems, the analysis itself is not limited by the order of the equation, and the principles can be ex-

tended to higher-order systems, with suitable engineering judgment.

It is further observed, that the zero-phase component influences only the amplitude of the response, while the inphase and quadrature components modify the amplitude, as well as the frequency of the response. Thus it is seen that these new concepts isolate important characteristics into quantities which represent a better criterion of the controlling factors. This feature is of great help in the synthesis procedures.

Another important feature of this technique is its striking analogy to the classic technique of symmetrical components. The more important of the analogues are indicated in Table I, while Table II shows the main points of difference.

The technique has been applied to evaluate the transient response of a multiplicative feedback control system.¹ The instantaneous error of the system to unit step input is governed by the equation

$$\frac{d^3e}{dt^3} + \frac{d^2e}{dt^2} + \left(1 - \frac{1}{2}e^2\right) \frac{de}{dt} + \frac{1}{2}e = 0. \quad (1)$$

The initial conditions of the error are given by

$$e(0) = 0.5, e'(0) = 0 \text{ and } e''(0) = 0. \quad (2)$$

The solution of the above non-linear equation is obtained by the principle of variation of parameters; and is given in equation (3).

$$e(t) = -\frac{1}{6}e^{-2t} \sin\left(t + \frac{\pi}{2}\right) + \frac{2}{3}e^{-t/2}. \quad (3)$$

Thus, the transient response of the system for unit step input is given by

$$C(t) = 1 + \frac{1}{6}e^{-2t} \sin\left(t + \frac{\pi}{2}\right) - \frac{2}{3}e^{-t/2}. \quad (4)$$

In equation (4), $C(t)$ is the response-vector, $1-(2/3)e^{-t/2}$ is the zero-phase component, which modifies only the amplitude of the response, while $(1/6)e^{-2t} \sin(t + \pi/2)$ is the inphase component which modifies both the amplitude and the frequency of the response. The quadrature component is zero.

Equation (4), derived analytically, shows very favourable agreement with the analogue computer study as given in ref. 1.

It is believed that this technique will lead to further developments in the theory, and application to non-linear control systems, possibly even for random inputs.

The detailed paper will be published elsewhere.²

* Department of Power Engineering, Indian Institute of Science, Bangalore 12 (India).

TABLE I
Analogues

Symmetrical components	Space-phase components
1 Number of phases of the electrical system ..	Order of the governing equation
2 Unbalance effects ..	Non-linear effects
3 Mutual coupling between phases due to dis-symmetry ..	Presence of cross-harmonic terms
4 Positive and negative sequence components ..	Inphase and quadrature components
5 Zero-sequence component ..	Zero-phase component
6 A simple mathematical representation of an unbalanced electrical system	A simple mathematical representation of a non-linear physical system
7 Enables stability study of power systems ..	Enables stability study of physical systems governed by the non-linear differential equation
8 Valid for analysis of transient as well as steady state behaviour (transient analysis by using Lyon's approach)	Valid for analysis of transient as well as steady state behaviour
9 Various time constants of the system can be determined	Time of rise, time of settling and other relevant time constants can be determined
10 Initial currents or voltages can be accounted for ..	Initial conditions can be accounted for
11 Suitable for study of transient disturbances and fault conditions	Any type of input in closed form can be studied, and instruments can be devised to control extraneous disturbances
12 Grounding phenomena associated with zero-sequence component	Zero-phase component influences only the amplitude of the response, while the inphase and quadrature components influence both the amplitude and the frequency

TABLE II
Differences

Symmetrical components	Space-phase components
1 Linearity is assumed in the derivation of the equivalent representation ..	The only assumption made is that higher harmonics in the response of the non-linear component are adequately filtered out by the linear part. This assumption is quite valid and practical with non-linear control systems
2 Sequence currents, voltages and impedances ..	The only variable is the system response
3 Evaluation of sub-transient parameters ..	None
4 Synthesis of networks to represent faults ..	Synthesis of components to represent non-linear effects is not possible because of the assumption made
5 Special features in the application to rotating machines	No essential difference in application to static and dynamic non-linear components
6 Sequence components are coplanar for any number of phases	Phase-space components are mutually orthogonal and located in space

1. Ku, V. H., *Analysis and control of non linear systems*, (Book). The Ronald Press Co., New York, 1958, pp. 312-320.

2. Accepted for publication in the *Journal of the Franklin Institute*, U.S.A.

ALPHA-ACTIVITY OF DRINKING WATERS OF BRITAIN

INVESTIGATION of the nature and levels of naturally occurring radioactivity in human foods and potable waters is of vital interest. Prof. Mayneord of the Institute of Cancer Research, London, has reported the results of experiments on the α -activity of drinking waters supplied to the population of Britain. (In passing it may be noted that as early as 1902, J. J. Thomson made observations on the radioactivity of Cambridge water).

Mayneord and his collaborators have measured the radium-226 content of 71 drinking waters of Britain. The water samples were collected from several points of view, including the size

of population supplied, and the nature of the associated geological formations. The samples can be divided broadly into five types, namely, (A) Spa waters which possess high contents of mineral matter; (B) Waters of Cornwall parts of which county are known to have deposits of uranium and radium; (C) Ground waters from boreholes in geological strata other than chalk; (D) Ground waters from boreholes in chalk, and (E) Surface waters from rivers, lakes and reservoirs.

In the experimental procedure, a litre of each specimen of water was evaporated to dryness and the α -activity of the residue measured

using an α -ray counting technique. Measurements were made on each specimen of residue immediately after evaporation and at intervals of a few days during the following 30 days, by which time the radon-222 and its α -emitting daughters Ra-A, and Ra-C' would have reached equilibrium with the radium-226 present. After 30 days no further change could be detected in any of the specimens.

The mean α -activities, in $\mu\mu\text{c}/\text{litre}$, of the various groups are as given below. The solid residue in parts per million and the α -activity, in $\mu\mu\text{c}/\text{gm.}$, of the residue are shown in brackets.

(A) Spa waters : 25.1 (2500, 14.6); (B) Cornish waters : 2.2 (90, 28.4); (C) Borehole waters (not chalk strata) : 1.4 (400, 3.7); (D) Borehole waters (in chalk) : 0.34 (200, 1.5); (E) Surface waters : 0.18 (100, 3.2).

It may be pointed out that in considering the exposure of large populations in relation to somatic effects, the maximum permissible level for soluble radium-226 in water suggested by the International Commission on Radio-logical Protection is 3.3 $\mu\mu\text{c}/\text{litre}$.—(*Nature*, 1961, 189, 348).

RUSSIA SENDS FIRST MAN INTO SPACE

AN epoch-making success in space science was achieved by Russia on April 12, 1961, when she launched the first man into space and brought him back alive and well. The satellite space ship was called "Vostok" (the East) and the first cosmonaut who safely travelled in it and landed back on earth was Flight Major Yuri Alexeyevich Gagarin, a citizen of the USSR.

The launching of the multi-stage space rocket at 9.07 Moscow time on April 12, 1961, was successful and after attaining the first escape velocity and the separation of the last stage of the carrier-rocket the space ship went into free flight on an orbit around the earth.

The period of revolution of the satellite space ship around the earth was 89 minutes 6 seconds. The minimum distance from the earth (at perigee) was 175 kilometres and the maximum (at apogee) was 302 kilometres. The angle of inclination of the orbit plane to the equator was 65 degrees 4 minutes.

The space ship with the navigator weighed 4,725 kilograms, excluding the weight of the final stage of the carrier rocket.

Bilateral radio communications were maintained with the space navigator. The frequencies of the short wave transmitters on board were 9.019 megaherz and 20.006 megaherz and in the ultra short wave range 143.625 megaherz. The condition of the navigator in flight was observed by means of radio telemetric and television systems.

According to reports received from board of "Vostok" space ship at 9.22 Moscow time, Major Gagarin, while over South America, reported "flight is proceeding normally, I feel well". Later, when over Africa 10.15 Moscow time Gagarin reported that he was withstanding the state of weightlessness well.

At 10.25 Moscow time Gagarin began his descent to the Soviet Union. He landed in a pre-determined area at 10.55 Moscow time. He was in space for 108 minutes. This means he made just over one orbit of the earth.

Academician Blagonravov said that the first astronaut "participated to a certain degree" in his return to the earth. He was fully conversant with the use of the equipment in the space ship, "even to make small repairs if necessary" during the flight.

The successful recovery of a space ship demands precision control of the ship during flight and landing. At a definite moment the orbital space ship receives the command from earth to separate the part remaining in orbit and to start the descent. It leaves the orbit and starts on a new trajectory. Naturally, the place of landing cannot be arbitrary, therefore it is necessary to select the right time for switching on the braking engines and most accurately take into account the ship's actual speed and its position in orbit. If the mistake in determining the speed amounts to only one metre per second and the error in determining the altitude is equal to one kilometre, then the ship will deviate from the planned point of landing by dozens of kilometres.

The entire landing operation demands the extraordinarily smooth and precise work of many mechanisms, a most careful account of the actual movement of the ship and timely command from earth.

It will be recalled that the first step leading towards the present achievement was taken on October 4, 1957, when Russia put into orbit the first earth satellite Sputnik I. In the three and a half years which have elapsed since then 51 space satellites have been sent, 38 by America and 13 by Russia.

LETTERS TO THE EDITOR

**EXPERIMENTAL STUDY OF
TRANSITION PROBABILITIES IN
ASTRAL RADICALS: LaO (B → X)
SYSTEM**

Of the few connected molecules studied for the intensity distribution, we have already reported the study of the bands of TiO and VO.¹ Another molecule in the series is LaO and it being of considerable astrophysical significance,² we give below the results of transition probabilities derived from the intensity distribution for the yellow (B → X) system of the molecule. The excitation source in this case is the carbon arc at atmospheric pressure, lanthanum oxide being packed in the lower positive carbon electrode. The technique of photographic photometry has been applied for quantitative estimation of intensities, which are taken as peak values near the band heads. These values have been utilised to arrive at the estimation of experimental transition probabilities as the ratio

$$\frac{\left(\frac{I}{v^4}\right)_{v'v''}}{\sum \frac{I}{v^4}}$$

which could be easily deduced from the measured value of intensity I for each band. The experimental procedures have been described in detail in an earlier paper.¹ The values of experimental transition probabilities so obtained are entered in Table I.

It is expected that these results on the LaO molecule will be particularly useful to astrophysicists. With the use of these experimental transition probabilities, N. Sreedhara Murthy³ has assigned Δr_e , the difference in the internuclear separations of B and X levels of LaO to be 0.038 Å.

TABLE I

Band v', v''	Experimental transition probabilities	Band v', v''	Experimental transition probabilities
0, 0	0.79	2, 3	0.40
0, 1	0.21	2, 4	0.08
0, 2	0.05	..	..
1, 0	0.16	3, 1	0.07
1, 1	0.57	3, 2	0.26
1, 2	0.31	3, 3	0.27
1, 3	0.05	3, 4	0.49
2, 0	0.05	4, 2	0.06
2, 1	0.14	4, 3	0.29
2, 2	0.31	4, 4	0.10

Department of Physics, N. R. TAWDE.
Karnatak University, Dharwar,
Department of Physics, P. V. CHANDRATREYA.
Ruparel College, Bombay,
March 6, 1961.

1. Tawde, N. R. and Chandratreya, P. V., *Ind. J. Phys.*, 1955, 29, 388.
2. Keenan, P. C., *Ap. J.*, 1948, 107, 420.
3. Sreedhara Murthy, N., *Nature* (London), 1961 (in press).

**AMPEROMETRIC DETERMINATION
OF CERIUM (IV) AND Fe (III)**

THE normal oxidation-reduction potential of the system Ce⁴⁺/Ce³⁺, $E_0 = 1.61$ volt depends on the acidity to a very small extent and consequently ascorbic acid can be used as a reducing agent for the quantitative determination of cerium at the rotating platinum electrode (RPE) at a potential of -0.16 to +0.56 volt *versus* saturated calomel electrode (SCE), when ascorbic acid does not yield an oxidation current.¹

A standard solution of ascorbic acid was preserved by the addition of formic acid. Ferric and cerium sulphate were standardised by the usual methods. Titration was carried out on the basis of the reduction current of cerium (IV) at a potential of +0.36 volt *versus* SCE. The experimental arrangements were as described earlier.^{1,2} The acidity of the solution has an important bearing on the experimental results and good titration results are obtained in 2.5 M sulphuric acid medium at $50 \pm 5^\circ\text{C}$, which was arrived at empirically. In higher acid solution, the oxidation-reduction potential of ascorbic acid increases and thus, its reducing action would be specific. Thereby it was possible to prevent the reduction of iron in the mixture of both; and cerium (IV) was successfully titrated under the said conditions. After completion of the reduction of cerium, corresponding to the stoichiometric reaction of this constituent, as established by a fall in the diffusion current for its reduction to zero, 8.0 M ammonium hydroxide was added to the titration mixture until a reddish-brown precipitate of ferric hydroxide appeared; which was then dissolved in 0.1 N sulphuric acid by dropwise addition of the acid. The resulting solution was heated to 60°C . for about five minutes; it was cooled and adjusted to pH 1.5. The mix-

ture was then titrated again at RPE versus SCE at $50 \pm 5^\circ\text{C}$. without the appliance of an external emf against the standard ascorbic acid till the cathodic current approached zero or a constant value in the vicinity of zero. About twelve solutions of varying composition, 0.915 to 3.664 mg. cerium and 1.421 to 7.456 mg. iron present together in 25 ml., were used for the successive determinations of these elements with success. Experiments were repeated several times for good and concordant results. Graphical method was employed to determine the equivalence point of these determinations.

The results obtained for the successive determination of cerium and iron are good and satisfactory, and conditions have been established for the amperometric titrations of these elements present together in a mixture. The difference between the amount taken and found is within the experimental error, which is always less than 2.0%. It is observed that the estimations at higher dilutions yield results with greater accuracy and precision.

Electrochem. Lab., D. SINGH.
Banaras Hindu Univ., MISS ASHA VARMA.
December 15, 1960.

1. Singh, D., *J. Scientific Res.*, BHU, 1959-60, **10**, 46.
2. Ko'thoff, I. M., et al., *J. Am. Chem. Soc.*, 1950, **72**, 1952; *Anal. Chem.*, 1951 **23**, 783; 1953, **25**, 1030; 1955, **26**, 299 and 366.

EFFECT OF GEOLOGICAL AGEING ON THE PARTICLE SIZE OF THE BONE MINERAL

ACCORDING to the present concept the bone is built up of microcrystals which are cemented together into macroscopic particles embedded in a collagen mesh. In the present paper we report some of our data on the powder diffraction patterns of modern as well as prehistoric bones, including a specimen as old as the Lower Triassic period, which indicate changes in particle size.

The bone samples studied in this series belonged to animals. The Harappa bone was selected from this Department's collections. The older geological specimens were obtained from Geological Survey of India through the courtesy of its Director. Table I gives a fuller information of the specimens.

A fine powder of the bone sample under investigation was obtained by filing with a jeweller's file from compact part of the bone, and powder photographs were taken in a Guiner

TABLE I
Identification of the bone specimens studied by
X-ray diffraction

Regd. No.	Identification	Locality	Age
..	<i>Bos indicus</i> Lum. Pelvis	West Bengal	Modern
H.157	<i>Bos indicus</i> Metatarsal	Harappa	Chalcolithic
K8/672	<i>Bos or Bubalus</i> Metacarpal	Allahabad Gangetic Alluvium	Pleistocene Alluvium
K13/610	Tibia of a bovid	Nila	Middle Siwaliks L. Pliocene
K47/580	<i>Dicynodon</i> <i>orientalis</i> Humerus	Deoli	Panchet L. Triassic

Quadruple Focussing Camera with quartz monochromator, using K_α radiation.

The powder patterns were analysed by the elegant method suggested by Hesse (1948) and further extended by Stosick (1949), which has been found to be very efficient in the present studies. The mean values of the axial lengths of the hexagonal unit cell of the bone crystal calculated from our data come out as $a_0 = 9.40 \text{ \AA}$ and $c_0 = 6.88 \text{ \AA}$. These values are in close agreement with those reported by Carlstrom (1955): $a_0 = 9.412 \text{ \AA}$ and $c_0 = 6.882 \text{ \AA}$. The observed values of the spacings in the powder photographs of the different specimens are all found to agree well with the calculated values, but the lines in the photographs exhibit varying sharpness and resolution. The resolution was the highest in the L. Triassic specimen and the lowest in the modern bone. Figure 1 represents the diffraction patterns for all the five specimens mentioned above.

From the diffraction photographs it appears that 'ageing' does not bring about any crystalline structural change in the compact bone mineral. However, it appears that the crystallites gradually but very slowly gain in size in all directions within the aggregates.

Although the patterns of all the specimens agree mutually in a general way they undoubtedly exhibit certain graded differences between them. Thus, the reflection (212) and (310) are not resolved quite clearly in the Modern bone, imperfectly resolved in the Harappa bone, but in other older specimens they appear with increasing intensity and sharpness. Similarly, the triplet (321), (410) and (402) are not at all resolved but appear together as a band in the Modern as well as the Harappa bone. In the Pleistocene sample, however, the reflexion (321) is discernible as a line but the other two are not

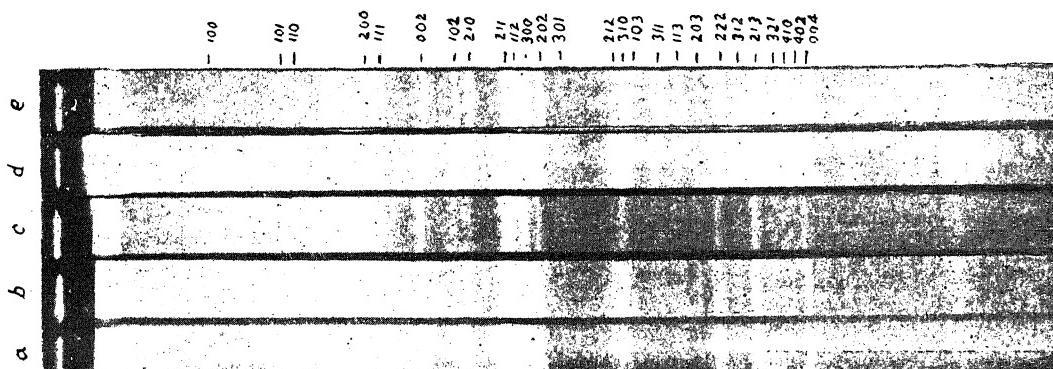


FIG. 1. Debye-Scherrer patterns of bone mineral : (a) specimen of bone—Modern; (b) specimen of bone—Harappa; (c) specimen of bone—Pleistocene; (d) specimen of bone—L. Pliocene; (e) specimen of bone—L. Triassic.

separately identifiable. These lines are resolved completely in L. Pliocene. Reflexions (211) and (112) are partially resolved in L. Triassic specimen but not at all resolved in other bone samples. Again lines (102) and (210) appear with increasing sharpness and intensity from the Harappa to the L. Triassic but they are totally unidentifiable in the Modern bone. The reflexion (301) is found to be completely merged in the background in the case of the Modern bone as well as the Harappa bone, but it stands out as a clear line with increased definition in the L. Pliocene and the L. Triassic bones. The reflexion (103) appears as a faint line in the L. Triassic but not at all discernible in the other specimens. This graded difference in the definition of the reflexions may be attributed to the growth of the sizes of the crystallites, as already stated.

It would be a matter of great interest in anthropology and archaeology, if the graded characteristics of X-ray diffraction patterns of the skeletal remains briefly indicated above could fruitfully be made to yield an index for 'ageing' of the bone specimens. The number of specimens studied is, however, not large enough to prove this conclusively. Further investigations are in progress to examine this possibility.

The authors are much indebted to the Director, Geological Survey of India, for kindly supplying the bone specimens of known geological ages and to the Director, Department of Anthropology, for the facilities offered. Thanks are also due to Dr. S. C. Chakrabarty, of Allahabad University, Physics Department, for helpful discussions.

Dept. of Anthropology, D. P. MUKHERJEE.
Govt. of India, S. R. DAS.
Indian Museum, Calcutta-13.
January 30, 1961

1. Carlstrom, D. and Finean, J. B., *Acta Radiol. Suppl.*, 1955, 121.
2. Hesse, K., *Acta Cryst.*, 1948, 1, 226.
3. Stosick, A. J., *Proc. Phys. Soc.*, London, 1949, 51, 99.

THROWING POWER OF LEAD NITRATE BATH FOR THE ANODIC DEPOSITION OF LEAD DIOXIDE

SEVERAL workers¹⁻⁵ have carried out investigations on the throwing power of different plating solutions commonly employed in practice and also suggested formulae for calculating the same. Recently Jelinek and David⁶ introduced a new term known as "Throwing Index" which also represents a direct measure of the throwing power of the bath. Such studies appear to have been confined mainly to plating baths, and as such for depositions on cathodes.

The present authors during their studies on the preparation of suitable lead dioxide electrodes to be used as insoluble anodes in electrolytic oxidations, found that the anodic deposition of lead dioxide could be easily carried out on graphite and/or carbon substrate^{7,8} from a bath containing lead nitrate and copper nitrate. In this deposition also, it is important to find out the capacity of the solution to give deposits even in the recesses of the anode, so that a non-porous, adherent deposit without pittings is obtained, which can effectively protect the substrate. Hence the throwing power studies for the anodic deposition of lead dioxide from lead nitrate bath was taken up.

Bath conditions employed are given in Tab'e I. Anodes were nickel plated mild steel plates (2 cm. × 2 cm.) attached to the sides of the cell breadthwise. The cathode was copper gauze with a copper frame (2 cm. × 2 cm.).

The cathode was positioned according to the linear ratios desired.

TABLE I

Conditions: Cell used, 12 cm. \times 2 cm. \times $2\frac{1}{2}$ cm.; volume of electrolyte 60 c.c.; composition of the electrolyte, 350 g./l., $Pb(NO_3)_2$ and 20 g./l. $Cu(NO_3)_2$; temperature, 30° - 32° C.; pH, 4.0 at start; current passed, 0.5 amp.; Duration, 10 minutes.

Expt. No.	Linear ratio L	PbO_2 ratio M	Throwing power (%)	
			Field's formula L-M	$\frac{L}{L+M-2} \times 100$
1	2	2.037	-3.2	
2	3	3.135	-3.3	
3	4	3.911	-1.5	
4	5	4.952	+0.6	
5	11	11.09	-0.45	

DISCUSSION

From the results of Table I, it is seen that the values of throwing power show a trend in that they pass through a maximum which is rather peculiar. For the determination of the throwing index, a graph was drawn taking linear ratio on the abscissa and the deposited lead dioxide ratio on the ordinate and a straight line was obtained. From this the throwing index, calculated from the reciprocal of the slope, was found to be nearly one, which is somewhat comparable to those for some of the common baths used for electroplating of metals. The determination of the throwing index could thus be made use of for the study of the effect of current density, temperature, etc., on the anodic deposition of lead dioxide as well.

The authors express their sincere thanks to Prof. K. S. G. Doss, Director of the Institute, for his keen interest and encouragement during this investigation.

Central Electrochemical Research Institute,
Karaikudi-3,
November 21, 1960.

K. C. NARASIMHAM.
S. SUNDARARAJAN.
H. V. K. UDUPA.

1. Haring, H. E. and Blum, W., *Trans Am. Electrochem Soc.*, 1923, **44**, 313.
2. Heatley, A. H., *Ibid.*, 1923, **44**, 283.
3. Field, S., *J. Electrodep. Tech. Soc.*, 1934, **9**, 144.
4. Pan, L. C., *Trans. Am. Electrochem Soc.*, 1930, **58**, 423.
5. Gardam, G. E., *Trans. Faraday Soc.*, 1938, **34**, 698.
6. Jelinek, R. V. and David, H. F. *J. Electrochem. Soc.*, 1957, **104**, 279.
7. Udupa, H. V. K. and Narasimham, K. C., *Indian Patent No.* 66195, December 22, 1958.
8. Narasimham, K. C. and Udupa, H. V. K., "Preparation of Lead Dioxide Electrodes—Part I"—Presented at the symposium on "Electrolytic Cells" held at Karaikudi in December 1958 (Under publication).

CONDUCTIMETRIC STUDY ON THE PRECIPITATION OF ARSENITES OF LEAD AS A FUNCTION OF THE pH

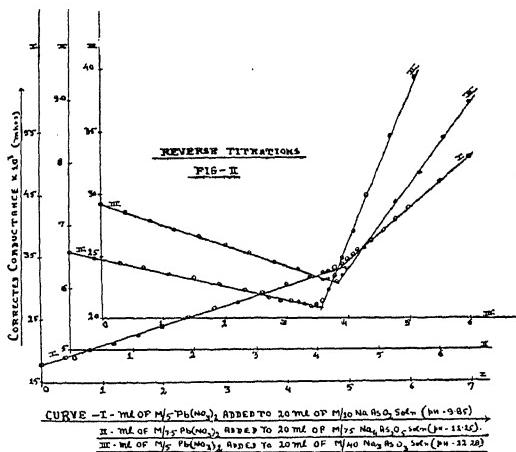
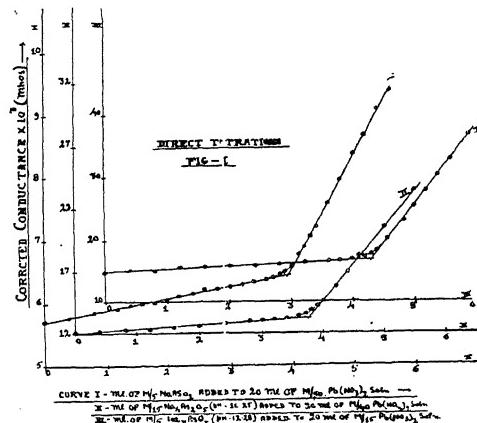
The precipitation of $NaAsO_2$ solution by $Pb(NO_3)_2$ causes the formation of complex arsenites whose composition varies with the pH. The investigations of these salts are made difficult due to the adsorption of AsO_2^- by the metal hydroxides, the easy conversion of orthoarsenite to pyro- and metaarsenite, and to the fact that these dissolve in excess of alkali or acid.¹ Consequently analytical methods have failed to give a correct view of their composition. A survey of literature reveals that the results of earlier workers²⁻⁵ were mainly based on the analytical investigation of the precipitates formed by mixing lead salts and alkali arsenites under different conditions and they reported the formation of several compounds of varying compositions. Besides, it appears that the formation of arsenites has not been studied at different H^+ ion concentration of the medium which plays an important role in their precipitation. Hence the present investigation has been undertaken.

The formation and composition of lead arsenite obtained by the interaction of $Pb(NO_3)_2$ and $NaAsO_2$ at definite pH levels—9.85, 11.25 and 12.28 have been studied by conductance measurements. The conductance of the solution was measured as usual by Kohlrausch Universal bridge and corrected for the dilution effect. Using different concentrations of reactants, conductimetric titrations were performed by the direct and the inverse methods.

The pH of stock solution of $NaAsO_2$ was measured by a glass electrode (range 1-13 pH) and found to be 9.85. The variations of the latter were obtained by the progressive additions of calculated quantities of $NaOH$ solutions to $NaAsO_2$. When $NaOH$ is mixed with $NaAsO_2$ in the molecular ratio 1 : 1 and 2 : 1, the corresponding compounds are $Na_4As_2O_5$ (sodium pyroarsenite) and Na_3AsO_3 (sodium orthoarsenite) and the pH of their solutions was found to be 11.25 and 12.28 respectively.

It is observed (Figs. 1 and 2) that when these alkali arsenite solutions are added to $Pb(NO_3)_2$ and vice versa and the conductance measured in reciprocal ohms and plotted against the volume of the titrant added, a distinct break in titration curves is obtained at a point corresponding to the formation of different arsenites depending upon the pH; lead metaarsenite $Pb(AsO_2)_2$ or $PbOAsO_3$ at pH 9.85; white gelatinous precipitate of lead pyroarsenite having the molecular formula $Pb_2As_2O_5$ or $2 PbOAs_2O_3$.

at pH 11.25 and normal lead orthoarsenite $\text{Pb}_3(\text{AsO}_3)_2$ or $3\text{PbO} \cdot \text{As}_2\text{O}_3$ at pH 12.28.



Figs. 1-2

The conductivity titrations give accurate and dependable results. The addition of alcohol in varying concentrations to the reaction mixture slightly improves the end point, for its presence reduces the adsorption of AsO_4^{3-} and also the solubility of the precipitates and hence a closer approach to the theoretical values is envisaged.

In direct titrations (Fig. 1), on adding alkali arsenite mixture to lead salts, a white precipitate is first formed which settles down quickly. On further addition of the reagent after the end point, the precipitate assumes a colloidal form. In the reverse case (Fig. 2) the precipitate formed remains in colloidal state until the end point is reached, after which it settles down leaving clear supernatant liquid.

Chemical Laboratories, RAM SAHAI SAXENA.
Govt. College, G. P. SAXENA.
Kota (Rajasthan),
January 19, 1961.

1. Ephraim, F., *Text-Book of Inorganic Chemistry*, Gurney and Jackson, London, 1949, p. 745.
2. Stavenhagen, A., *J. Prakt. Chem.*, 1895, 2, 51.
3. Filhol, E., *J. Pharm. Chim.*, 1843, 14, 331.
4. Bloxam, G. L., *J. Chem. Soc.*, 1862, 15, 281.
5. Kuhn, O. B., *Arch. Pharm.*, 1852, 2, 69, 267.
6. Reichard, C., *ber. dtsch. Chem. Ges.*, 1894, 27, 1019.

BEHAVIOUR OF THE CHROMIUM GLYCINE COMPLEX AT THE DROPPING MERCURY ELECTRODE

GLYCINE does not enter into complex ion formation with chromium ions at the ordinary temperature. However, if the mixture is heated for an hour on a water-bath maintained at about 90° , a violet coloured complex is formed. The reduction of this complex at the dropping mercury electrode in different supporting electrolytes, viz., phosphate buffers (pH range 5.20 to 9.7), KCl , and $\text{KCl} + \text{HCl}$ was investigated.

A mixture of 2 c.c. of glycine (1 M) and 1 c.c. of 0.02 chromic chloride was heated on the water-bath until the violet colour was fully developed. 1.5 c.c. of this solution was taken in the polarographic cell and to it 0.5 c.c. gelatine (0.01%) was added and the volume made up to 8 c.c. by the supporting electrolytes. Measurements were made with the help of Fisher Electropode in conjunction with the Multiflex galvanometer type MGF2 in the external circuit. Purified nitrogen was passed in the cell to maintain the inert atmosphere. The temperature was maintained at $35 \pm 0.1^\circ \text{C}$.

The complex was found to be reducible at the dropping mercury electrode but reversible waves were not realised in any of the supporting electrolytes used. The $E_{(1/2)}$ values and $E_{(2)} - E_{(1)}$ values were as follows:

pH of supporting electrolyte	$E_{(1/2)}$	$E_{(3/4)} - E_{(1/4)}$
Phosphate buffer		
5.20	1.10	0.16
6.10	1.24	0.16
6.45	1.26	0.16
6.70	1.26	0.14
6.85	1.30	0.14
7.10	1.32	0.14
8.00	1.32	0.14
8.70	No wave	—
9.70	No wave	—
HCl + KCl (0.1 M)		
2.30	No well-defined wave	—
KCl (0.1 M)		
6.60	0.96	0.10

From the results it was noticed that only in the case of KCl as supporting electrolyte, a well-defined plateau for the polarographic wave is realised. Even in this case no linear relationship was obtained on plotting $E_{(1)}$ against-

$\log c$ of glycine which could help in determining the structure of Cr (iii) glycine complex.

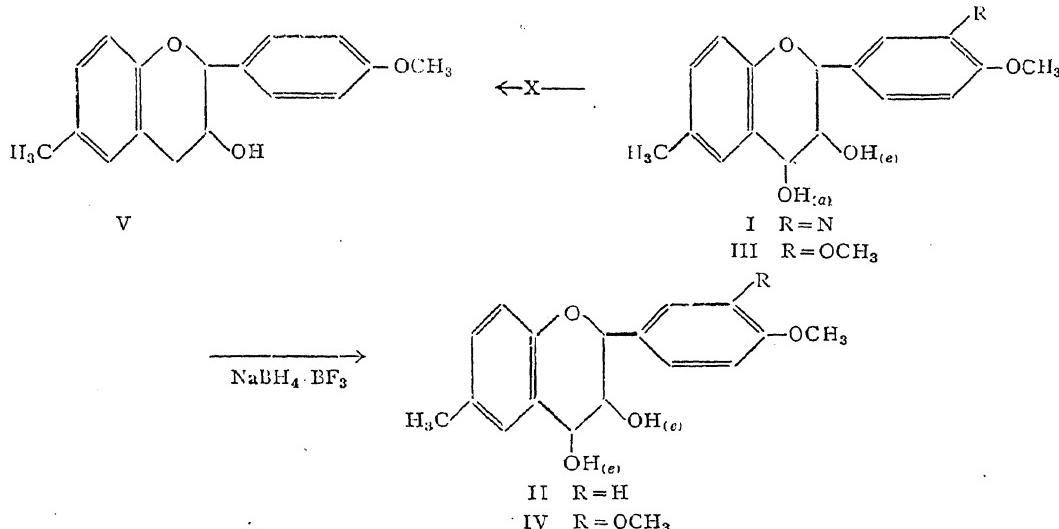
Thanks are due to Prof. M. O. Farooq for his interest in the work.

Department of Chemistry, A. AZIZ KHAN.
Aligarh Muslim University, WAHID U. MALIK.
Aligarh (India),
December 19, 1960.

EPIMERISATION AT THE C₄-CENTRE OF A FLAVAN-3,4-DIOL

With a view to assigning definite stereochemical configurations to the synthetic catechins,¹ the synthesis of the trans-isomer of 6-methyl-4'-

The above method of epimerisation of C₄-OH gives us an elegant method for the synthesis of the trans-diequatorial flavandiol which is hitherto available through the reduction of the dihydroflavonol⁴ in extremely low yields. The general applicability of this epimerisation for the synthesis of a trans diequatorial flavandiol was proved by extending it to the epimerisation of cis-6-methyl-3':4'-dimethoxy flavan-3:4-diol⁶ (III; m.p. 183-84°) to its trans-isomer⁶ (IV; m.p. 203-04°). It is relevant to note that epimerisation of melacacidin [C₄-OH_(e)] to isomelacacidin [C₄-OH_(a)] using hydrochloric acid is very recently reported by Clark-Lewis and Mortimer.⁷



methoxy-3-hydroxyflavan through the hydrogenolysis of the corresponding flavan-3:4-diol, stereochemistry of which is well established,² was attempted. It was recently reported that the reducing action of the metal hydrides is enhanced in presence of certain metal halides such as boron trifluoride and aluminium chloride and that the combined reagent — metal hydride + metal halide is used for hydrogenolysis.³ cis-6-Methyl-4'-methoxy flavan-3:4-diol [I; m.p. 169°; C₃-OH_(e), C₄-OH_(a)] was therefore treated with sodium borohydride boron trifluoride when its trans-isomer [II; m.p. 193°; C₃-OH_(e), C₄-OH_(e)] instead of the expected catechin (V) was isolated in about 40% yield. Sodium borohydride or boron trifluoride alone does not epimerise cis-flavandiol (I). Epimerisation of alcohols with lithium aluminium hydride-aluminium chloride has been reported earlier in the case of 4-t-butylcyclohexanol.⁵

Chemistry Department, M. D. KASHIKAR.
Institute of Science, A. B. KULKARNI.
Bombay-1, December 7, 1960.

1. Kashikar, M. D. and Kulkarni, A. B., *J. Sci. and Ind. Res.*, 1959, **18B**, 413.
2. Joshi, C. G. and Kulkarni, A. B., *J. Ind. Chem. Soc.*, 1957, **34**, 753.
3. Nystrom, R. F., *J. Am. Chem. Soc.*, 1955, **77**, 2544.
Venkataraman, K., *J. Ind. Chem. Soc.*, 1960, **37**, 247.
4. Joshi, C. G. and Kulkarni, A. B., *J. Sci. and Ind. Res.*, 1957, **16B**, 307. Kashikar, M. D. and Kulkarni, A. B., 1959, **18B**, 418.
5. Eliel, E. L. and Rerick, M. N., *J. Am. Chem. Soc.*, 1960, **82**, 1367.
6. Kashikar, M. D. and Kulkarni, A. B., Unpublished work.
7. Clark-Lewis, J. W. and Mortimer, P. I., *J. Chem. Soc.*, 1960, 4106.

AN ALL-GLASS SPRAYER FOR PAPER CHROMATOGRAPHY

IN recent years, various types of sprayers have been described.¹⁻⁵ Of these Ortegren's apparatus¹ is economical and easy to construct; but in order to get a fine jet of spray, an air-compressor and a finger-controlled port are required during spraying. To reduce the number of accessories, a modification in Ortegren's apparatus was made.

This apparatus (Fig. 1) consists of a reagent reservoir (A) with a quickfit socket (B) of

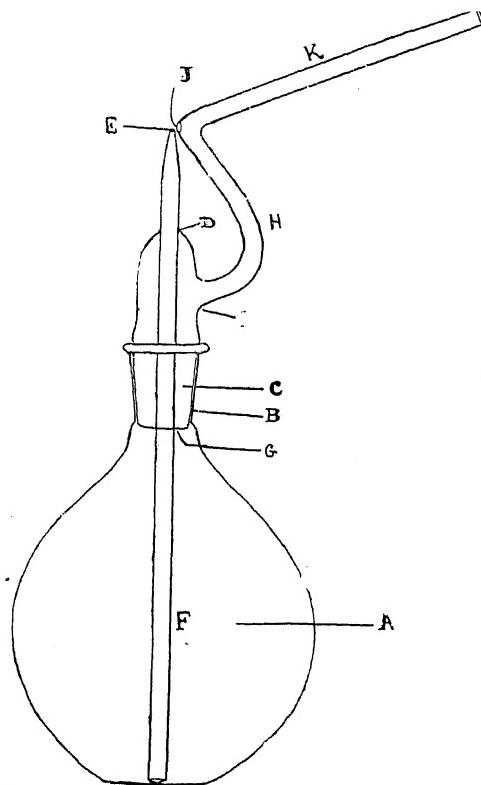


FIG. 1

B_{10} or any other standard size, and a quickfit cone (C) which exactly fits the socket (B). An uniform pipette nozzle (E) is drawn at D to a distance (DE) of about 3 to 5 cm. The exterior and interior diameters of the nozzle are 1.0 and 0.5 mm. respectively. A glass tube (F), about 0.5 to 0.8 cm. in diameter and 25 cm. long, is fused to the cone at D. To give greater stability to the pipette in the assembly, the tip of the cone is made to fuse to the pipette column at about three or four places at G. Another glass tube (H), about 20 cm.

long and of the same diameter as the pipette column, is fused at I, about 2.5 cm. from the ground joint. A circular aperture (J), about 2.0 mm. in diameter is blown at the exterior surface, i.e., facing the pipette and about 6 to 8 cm. from the fused end. The curvature of this glass tube is so adjusted that the aperture is situated about 0.5 mm. below the pipette nozzle and 1.0 mm. above it, while its side arm (K) which is about 10 cm. in length lies at approximately $\angle 100^\circ$ to the pipette. The tube F is cut to the size of the reservoir flask. The entire assembly is made of pyrex glass and the construction can be completed within 30 minutes. By using interchangeable joints, the sprayer can be made to fit flasks of any size or even a test-tube.

The sprayer modified in this laboratory has the following advantages:— (i) it is economical, i.e., the entire assembly is of glass and can be easily constructed, while the size of the reservoir flask may be adjusted according to the needs of the operator; (ii) spraying can be done with an air-compressor or by blowing with the mouth as desired; (iii) drops do not form while spraying; (iv) contamination and evaporation of the reagent (when the sprayer is not in use) can be minimized by using a quickfit stopper and (v) it can be dismantled and cleaned easily and, if required, it can be heated.

Institute of Science,

E. J. LEWIS.

Bombay-1,

ELLA A. GONZALVES.

February 18, 1961.

1. Ortegren, V. H., *Analyt. Chem.*, 1954, 26, 943.
2. Popov, P. V., *Org. Instituto im Ratsdye i gerichts-Prv.*, 1958, 314; *Chem. Abstr.*, 1960, 54, 8159d.
3. Wegmann, K., *J. Chromatog.*, 1959, 2, 321.
4. Wingo, W. J., *Analyt. Chem.*, 1953, 25, 1939.
5. Zweig, G., *Ibid.*, 1956, 28, 428.

HIGH STRETCH PAPER FROM SISAL FIBRE

IN an earlier communication¹ results of an investigation on the production of high stretch paper from coconut coir fibre were reported. It was suggested to us by Dr. D. Narayana-murti that sisal fibre should also be capable of high stretch as its spiral angle is large ($18\text{--}35^\circ$ according to Heyn; $25\text{--}38^\circ$ according to Sonntag²; and 23° according to Bell³). Therefore, an investigation was undertaken on the strength properties of standard sheets produced from sisal fibre by the sulphate process ($\text{NaOH} : \text{Na}_2\text{S} = 3 : 1$). The results are recorded in Table I. Comparative figures for

coconut coir taken from the earlier communication¹ are also included in the table.

TABLE I
Sulphate digestions of sisal fibre and strength properties of standard sheets

Serial No.	Digestion conditions and pulp yields			Strength properties of standard sheets made from pulps beaten to 300 ml. freeness				
	Total chemicals*	Digestion temperature	Digestion period	Unbleached pulp yield*	Breaking length	Stretch	Tear factor	Burst factor
1	14	162	3	66.0	6790	6.2	124	48.4
2	14	162	4	59.4	6900	6.5	133	55.0
3	16	162	3	60.8	8100	8.4	162	59.0
4	20	162	3	57.0	7380	7.7	134	57.4
5†	20	170	4	44.6	4350	9.0	107	26.4

* The % is expressed on the basis of the raw material (oven dry).

† Coconut coir used.

Under the conditions studied, the digestion conditions given in Serial No. 3 give the best results. Although the stretch of paper from sisal is slightly less than that from coir, the yield is much higher and the other strength properties are better. The colour of the paper from sisal is light-brown while that from coir is dark-brown.

Cellulose and Paper Branch, S. R. D. GUHA, Division of Chemical Technology, P. C. PANT. Forest Research Institute, Dehra Dun, January 9, 1961.

1. Guha, S. R. D., *Curr. Sci.*, 1960, **29**, 93.
2. From pages 83, 206, and 209 of *Die Chemie der Planzlichen Zellwand*, by E. Treiben. Springer Verlag, 1957.
3. Bell, W. A., *Science Newsletter*, No. 54, 39.

MERCUROCHROME AS A SPRAY REAGENT FOR AMMONIUM SALTS OF VOLATILE ORGANIC ACIDS

MERCUROCHROME has been employed as an indicator in acid alkali titration¹ as well as for identification of organic acids on paper chromatograms.^{2,3} This note describes its use as a spray reagent for volatile acids C₁-C₄ in the form of their ammonium salts.

R. L. Reid and M. Lederer⁴ have used bromoresol purple as a spray reagent for ammonium

salts of volatile organic acids, but the spots so obtained fade away rather quickly whereas those obtained with 0.1% mercurochrome in alcohol stay much longer, over several days. These spots are red in colour whereas those due to organic acids themselves^{2,3} are white. In both the cases the background is pink and spots fluoresce under ultra-violet. It was also found that the ammonium salts of volatile organic acids lent themselves to detection even in as low a concentration as 75 μ gm. when mercurochrome was used.

In the present investigation where the volatile organic acids produced during the progressive decomposition of fish are studied, mercurochrome was found to be an effective spray reagent. The presence of organic acids was detected by using paper chromatographic technique. Volatile organic acids were obtained by steam distillation of fish muscle,⁵ and were titrated against sodium hydroxide thus converting them into sodium salts. These sodium salts were converted into ammonium salts and were then applied to a filter-paper disk (Whatman filter-paper No. 1). The chromatogram was developed with n-butanol saturated with an equal volume of 1.5 N aqueous ammonia.⁴ It was sprayed with 0.1% mercurochrome when red bands due to ammonium salts of volatile organic acids appeared almost immediately against pink background.

The volatile organic acids so identified in the present investigation were formic acid, acetic acid, propionic acid, butyric acid. Acetic acid and butyric acid were found to be present in fresh fish extracts while formic acid, acetic acid, propionic acid and butyric acid appeared after 6 hours of decomposition. Further confirmation and estimation of these acids has been done using silica gel column.

The author thanks Dr. J. W. Airan for help and guidance.

MISS KAMAL A. JADHAV.

Dept. of Biochem.,
Wilson College,
Bombay-7,
January 16, 1961.

1. Airan, J. W., *Nature*, 1947, **160**, 88.
2. — et al., *Anal. Chem.*, 1953, **25**, 659.
3. —, *Jour. Univ. Bombay*, 1953, **22** (3), 29.
4. Reid, R. L. and Lederer, M., *Biochem. Jour.*, 1951, **50**, 60.
5. *Off. Methods of Anal. of Assoc. of Agri. Chem.*, 1955, 8th Edition, p. 312, 18-14.

ENDOTROPHIC SPORULATION AMONG SPECIES OF *STREPTOMYCES*

EARLIER studies in this laboratory on the nature of bacterial sporulation in aerobic sporeforming bacilli had revealed that the ability to sporulate endotrophically is widely distributed among species of the genus *Bacillus*.¹ While sporulation in the branched *Streptomyces* has undoubtedly certain distinctive features, a question raised by the earlier observations was whether the ability to sporulate in an environment that does not support growth is shared by species of *Streptomyces*, a bacterial genus with morphological and reproductive similarities to the typical moulds.

Fourteen authentic strains of *Streptomyces* representative of eleven species were examined. Vegetative mycelia free from spores were obtained as follows: free spores harvested from glucose yeast extract agar² were inoculated into 5.0 ml. of glucose yeast extract broth in 2.0 cm. × 6.0 cm. tubes and incubated in a sloped position which provided a good surface: volume ratio. Almost all spores germinated under these conditions in 36 to 48 hours when the incubation temperature was 27°–29°C. In each case, the absence of observable ungerminated spores was confirmed by careful microscopic examination. The vegetative mycelia thus obtained were washed four times in glass distilled water by centrifugation and suspended in 8.0 ml. of the water. The tubes were incubated at 27°–29°C. and microscopic observations for endotrophic sporulation made at intervals of 5, 7, 15 and 26 days. All microscopic observations were made on crystal-violet stained smears and at a magnification of × 1,000.

No mycelial growth was observed microscopically under these conditions. The results recorded in Table I suggest that the ability to sporulate endotrophically is distributed widely among the *Streptomyces* as was demonstrated earlier in the genus *Bacillus*.¹ Eight of the fourteen strains sporulate appreciably in 5 to 7 days while in the remaining strains the process is extended to 15 or even 26 days. Even within a single species there are notable differences among strains in the facility with which they sporulate. The morphology of mycelia that sporulate was found to be no different from the typical conidiospore-bearing hyphae of *Streptomyces* growing on liquid nutrient media.

This hitherto unreported observation that sporulation in many species of *Streptomyces* is an event which, as in the endospore-forming bacteria, can occur in the absence of growth and multiplication, suggests biochemical ana-

TABLE I

The ability of species and strains of *Streptomyces* to sporulate endotrophically in distilled water

Species and strain	Minimum time (days) required for appreciable* sporulation
<i>S. griseus</i> , MA-13	.. 5
<i>S. griseus</i> , B-150	.. 7
<i>S. viridochromogenes</i> , B-1511	.. 5
<i>S. lavendula</i> , B-1230	.. 7
<i>S. cinnamomeus</i> forma <i>cinnamomeus</i> , B-1285	.. 15
<i>S. netropis</i> , 2268	.. 5
<i>S. albus</i> , B-1685	.. 26
<i>S. albus</i> , S ₁₂	.. 15
<i>S. ruber</i> , S ₁₃	.. 5
<i>S. annulatus</i> , S ₁₄	.. 26
<i>S. flavus</i> , S ₁₆	.. 7
<i>S. lavendula</i> , S ₁₇	.. 5
<i>S. antibioticus</i> , S ₁₈	.. 26
<i>S. fradiae</i> , S ₂₀	.. 26

* At least an average of 50 spores observed per field at 1,000 magnification.

The strains used were made available through the courtesy of H. B. Woodruff, T. G. Pridham and Y. M. Freitas, to whom we are grateful.

logies between the sporulation process in bacilli and in *Streptomyces*.

Microbiology Department, S. NARAYANAN.**
S.B. Garda College, V. IYER.*
Navsari, January 15, 1961.

* Present address: Biological Laboratories, University of Rochester, Rochester-20, New York, U.S.A.

** Present address: Microbiological Research Laboratories, Alembic Chemical Works, Co., Ltd., Baroda-3.

¹1. Iyer, V. and Kanga, D. H., Proc. Ind. Acad. Sci., 1960, 14 B, 133.

2. Waksman, S. A., *The Actinomycetes*, Chronica Botanica Co., U.S.A., 1950.

SCREENING OF RICE VARIETIES FOR RESISTANCE TO FOOT-ROT DISEASE

Gibberella fujikuroi (Saw.) Wr. causes the 'bakanæ' disease of rice in Japan, while the imperfect form of this fungus, *Fusarium moniliforme* Sheld., causes the foot-rot disease of rice in India. The disease, though found to occur in many parts of India, has been reported to cause severe damage in Madras and Andhra States.¹ The ideal method of obviating loss due to disease is growing resistant or immune varieties. The present paper reports six new rice varieties resistant to the foot-rot disease (details to be published later), in addition to the few that had already been reported.²⁻⁴

The experiments were conducted in pots containing 250 g. sterilized soil. Twenty new

varieties of rice of Indian, Japanese and Egyptian origin were grown in *F. moniliforme* infested soil along with the controls MTU. 9 (susceptible) and PTB.7 (resistant). Four replicates were maintained for each variety with 15 seedlings per pot. The inoculum for the infested soil was given as follows: The fungus *F. moniliforme* was grown in sterilized soil-oats (9 : 1) for 21 days, then mixed with sterilized soil at 8% level and incubated for 24 hours. The seeds of the different varieties were surface sterilized with 1 in 1000 mercuric chloride, then sown and irrigated. The seeds sown in uninfested soil formed the controls.

HR. 98. Barring the two varieties PLA. 1 and HR. 35 which have been classified as moderately susceptible, the rest were all highly susceptible. Even the varieties resistant to the disease, however, were not immune; they take infection as seen by the presence of the fungus on plating out.

Of the six varieties now found to be resistant to the disease, HR. 98 (HR. 19 \times Norin. 18), HR. 101 (Norin. 20 \times HR. 19) and HR. 105 (Norin. 36 \times HR. 19) are recently evolved *Indica* \times *Japonica* hybrids from Andhra Pradesh. They are white-riced, medium to fine in quality, non-lodging, high yielding and of short dura-

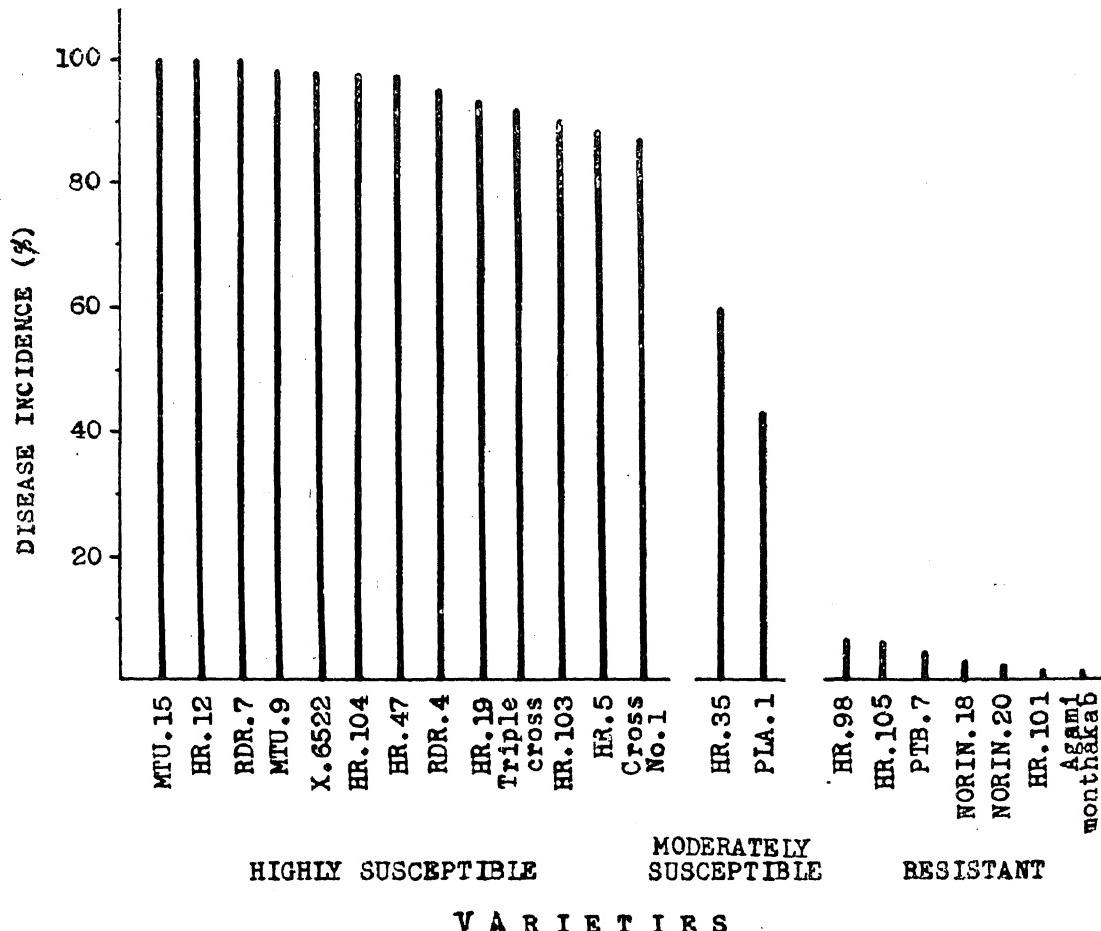


FIG. 1. Shows disease incidence on the 20th day after sowing. (The resistant varieties showed 1.7 to 6.7% disease incidence whereas the susceptible varieties showed a range of 43.3 to 100% incidence.)

The results are presented in Fig. 1 and have been found to be statistically significant at 5% level. The following six varieties are resistant to the disease: Agami monthakab, HR. 101, Norin. 18, Norin. 20, HR. 105 and

tion. These may be found useful where foot-rot is prevalent. The other three are coarse-grained *Japonica* types which may be useful for hybridization to induce foot-rot disease resistance in susceptible varieties.

I am deeply indebted to Prof. T. S. Sadasivan, Director, University Botany Laboratory, Madras, for encouragement during this investigation.
University Botany Lab., K. RAJAGOPALAN.
Madras-5, February 2, 1961.

1. Padmanabhan, S. V., *International Rice Commission News Letter*, 1956 **19**, 9.
2. Thomas, K. M., *Madras Agric. J.*, 1933 **21**, 263.
3. Padwick, G. W., *Manual of Rice Diseases*, The Commonwealth Mycological Institute, Kew, Surrey, 1950.
4. Ghose, R. L. M., Ghatge, M. B. and Subramanyam, V., *Rice in India*, I.C.A.R. Publication, New Delhi, 1956.

THE SANASAR CIRQUE

THAT the Jammu hills in and around Batote and other similarly situated hills in the range were extensively glaciated during the Great or the Pleistocene Ice-age lasting for nearly 50,000 years has been established by unmistakable evidences such as the grooved and polished rock surfaces in these hills¹ and the polished, striated and faceted boulders and pebbles enclosed in the upper Siwalik and Sub-Recent fluvioglacial deposits met with in the neighbourhood of Jammu.^{2,3}

Another evidence equally convincing and dependable of the existence of extensive snow-fields and glaciers in these hills during the Pleistocene times has been recently observed by the author at Sanasar, a picturesque hill-station, about 8,000 feet high above sea-level and some seven miles West of Batote. It consists of a vast spectacular depression called in glacial terminology a *cirque*, about half a mile long and a quarter mile wide, unaffected and unchanged by geological agencies. It has a distinctly amphitheatrical or horse-shoe-shaped outline, with precipitous and cliff-like high headwall, a much lower outer rock-edge on the opposite margin and a typical form of floor that gradually deepens more and more as the headwall is approached. It is this peculiar and reversed slope of the floor, resembling the seat of a gigantic easy-chair that is considered to be "the most dependable criterion for the identification of a cirque".⁴

It is at present occupied by a shallow marshy cirque-lake with a tiny stream issuing out of it through a cut in the outer rock-edge. The high precipitous headwall is evidently the result of quarrying action of ice on the back side of the great crevasse in the cirque-ice called the *bergschrund*. Some smaller cirques have also been observed in the hills, as for example, the Ashapati in Bhadarwah, but the Sanasar cirque is easily the most unique in the Himalayan

ranges South of the Pirpanjal, not only in respect of its extensive dimensions but for its clear-cut topography and outline. The size of the cirque provides an indication of the severity and duration of the glacial cycle in the Jammu hills so close to the plains of the State and the Punjab.

Formerly of the R. C. MEHDIRATTA.
University of Jammu and Kashmir,
Jammu, January 27, 1961.

1. Mehdiratta, R. C., *Nature*, London, 1959, **183**, 255.
2. —, *Ibid*, 1959, **184**, 833.
3. —, *Curr. Sci.*, 1960, **29**, 104.
4. Von Engeln, O. D., *Geomorphology* (The Macmillan Co., New York), p. 448.

CEREBROSPINAL LEPTOSPIROSIS IN BUFFALO-CALVES

DUE TO *LEPTOSPIRA HEBDOMADIS*

Losses due to a mysterious disease, characterised by convulsions, prostration and death in 3 to 4 hours in acute cases and by posterior paralysis in sub-acute and chronic forms were encountered among buffalo-calves at the Tarai State Farm dairy, Naini Tal, in India.

Mortality reached a peak in 1958 when as many as 101 out of 149 calves died on the same farm. The affected calves exhibited symptoms like stiffness of gait, inco-ordination of movement, weakness of hind-quarters, paralysis and ultimately recumbency and death. None of the calves showed haemoglobinuria and haematuria. It is interesting to note that the attendant signs of anaemia and haemoglobinuria of *L. hebdomadis* infection in bovines in Japan were not seen in India. Mostly the disease was afebrile and blood smears revealed no protozoa of aetiological significance.

Detailed post-mortem examination was carried out on three sick buffalo-calves that were transhipped to the Institute at Izatnagar, located at a distance of 50 miles from the dairy farm. All the internal organs appeared normal. Histological examination of sections of kidneys showed mild interstitial nephritis, the pattern of which led the senior author to look for leptospiræ which were demonstrated in Levaditi's stained sections. Consequent on histological evidence of leptospirosis, cultural studies were undertaken on three buffalo-calves showing the typical syndrome. Leptospiræ were isolated from suspensions of kidney, brain and lumbar portion of the spinal cord on inoculation into guinea-pigs and two-day-old baby chicks¹ as well as on direct seeding of Scuffner's modification of Vervoort's medium

and the tryptose-phosphate agar medium developed by Cox and Larson² (1957). Leptospiral soluble antigens were demonstrated in gel-diffusion plates when they reacted with rabbit hyperimmune serum to give a double zone. Further haemagglutination, haemolysis and corresponding inhibition⁴ tests confirmed their presence in urine as well. By agglutination and cross-agglutinin absorption tests, the isolate was found to be serologically identical with *Leptospira hebdomadis*. Leptospiræmia occurred on the sixth day in baby chicks and weanling guinea-pigs inoculated intraperitoneally with kidney, brain and spinal-cord emulsions but not with those prepared from liver, spleen and lungs. Viable leptospiræ were recovered in culture from these experimental animals. Experimental induction of the syndrome had since been achieved in healthy buffalo-calves on intra-conjunctival exposure to this serotype.

Serological examination of the blood samples of clinically sick calves showed high titres in the modified Cox's haemolytic test⁵ (1 : 512 to 1 : 1024) and rapid plate agglutination techniques^{6,7} (1 : 50 to 1 : 100). In the microscopic agglutination test, antibodies were found to be specifically directed against *L. hebdomadis* to titres of 1 : 20,000 to 1 : 40,000 and no cross-reaction or heterologous co-reactions were encountered. A random sample survey of the entire herd showed serological evidence of infection in as many as 30 out of 160 buffalo-calves. It is interesting to observe that many serologically positive reactors were asymptomatic. Also, a total of 95 adult buffalo-calves were screened when 25 animals reacted positively in the different serological tests.

Leptospira hebdomadis bacterin has since been employed to attempt controlling of losses due to this condition on this farm.

Though, *Leptospira pomona* was found to cause meningitis in cattle^{8,9} the diagnosis, as observed from published reports, had been based on serological or cultural grounds.

This is the first authentic report on cerebro-spinal leptospirosis due to *Leptospira hebdomadis* in cattle in India. To our knowledge, this is the second area of the world where infections of cattle with *L. hebdomadis* have been definitively demonstrated, the other being Japan. Leptospirological Lab., P. G. PANDE.

Division of Pathology P. C. SEKHARIAH,

and Bacteriology, P. K. RAMACHANDRA IYER.
Indian Veterinary R. R. SHUKLA.

Research Institute,
Mukteswar, Kumaon, October 21, 1960.

A HAEMATOXYLIN SQUASH TECHNIQUE FOR A STUDY OF THE NUCLEI OF RAT LIVER CELLS

THE haematoxylin squash technique devised recently for plant material¹ gave elegant staining of the nuclear organelles. It enabled a determination of the chromosome number of *Dolichos lablab*¹ and a demonstration of chromosomes with tandem satellites in some specimens of *Cicer arietinum*.² Unlike some of the staining procedures^{3,4} haematoxylin colours both the chromosomes and nucleoli irrespective of the composition of the fixative. It was thought desirable, therefore, to evaluate the suitability of the above technique for animal tissues.

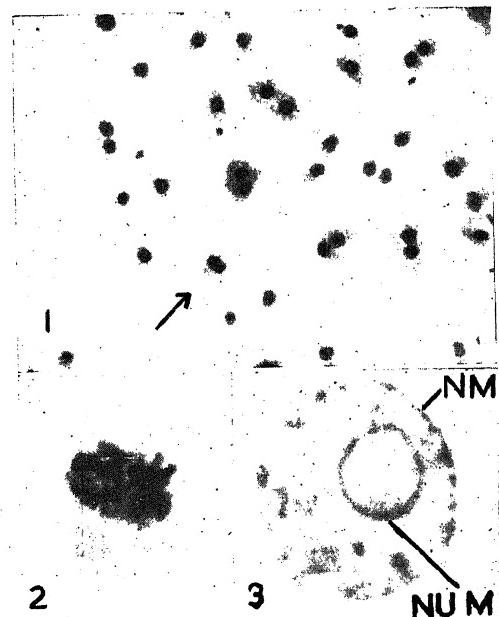
Small bits of the liver of white rat, about 1 mm. in thickness, were fixed in acetic alcohol (1 : 3) for 1 hr. and stored in 70% alcohol. When required, the material was down-graded and kept in water for 30 min. The bits were hydrolysed in N HCl at 60° C. for 5-6 min., washed in distilled water for 10 min., mordanted in 4% ferric ammonium sulphate for 10-20 min., washed well in distilled water for 10 min. and then stained with 0.5% solution of dark haematoxylin (Gurr) for 30 min.

A piece of the stained material washed well in water was transferred to a drop of 45% acetic acid on a slide and squashed under a coverslip coated with a thin layer of Mayer's albumen. When occasionally the separation of the cells was found unsatisfactory, the material was softened with 45% acetic acid at 60° C. for 2-6 min. before squashing. The process of softening has to be controlled carefully since acetic acid is also the medium used for destaining.

Temporary mounts sealed with paraffin wax could be kept for a week without loss of clarity. To make them permanent, the coverslips were released in a mixture of 45% acetic acid and tertiary butyl alcohol (3 : 1). The slides and coverslips were upgraded through mixtures of these reagents (1 : 1, 1 : 3) followed by two changes of 30 min. each of pure tertiary butyl alcohol. They were then recombined while mounting in canada balsam dissolved in tertiary butyl alcohol.

Figure 1 is of a field taken under the low power of the microscope to illustrate the separation of the cells. They were generally uni- or bi-nucleate. A rare divisional phase in the above field (indicated by arrow in Fig. 1) is shown in Fig. 2. The most interesting feature was the presence of a distinctly stained and well-defined membrane for the nucleolus (Fig. 3). This was rather surprising since

recent studies with the electron microscope^{5,6} could not substantiate the earlier claims regarding its existence. Confirmatory evidence for the presence of a nucleolar membrane is now being marshalled using a variety of staining techniques.



FIGS. 1-3. Fig. 1. Permanent Mount, $\times 100$. Note the separation of the cells. Fig. 2. The cell indicated by an arrow in Fig. 1 enlarged to show the divisional phase, $\times 1,000$. Fig. 3. Temporary Mount. The nucleus and nucleolus are bounded by membranes, $\times 2,600$.

NM, Nuclear Membrane. NUM, Nucleolar Membrane.

Grateful acknowledgement is made to the University Grants Commission for the award of a Senior Fellowship and to Dr. M. K. Subramaniam for encouragement.

Cytogenetics Laboratory, SARASWATHY ROYAN.
Dept. of Biochemistry,
Indian Institute of Science,
Bangalore-12, March 6, 1961.

1. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.
2. Meenakshi, G. and Subramaniam, M. K., *Ibid.*, 1960, **29**, 438.
3. Morrison, J. H., Leak, L. V. and Wilson, G. B., *Trans. Microscop. Soc.*, 1959, **78**, 358.
4. Tandler, C. J., *Stain Tech.*, 1959, **34**, 234.
5. Vincent, W. S., *Internat. Rev. Col.*, 1955, **4**, 269.
6. Whaley, W. J., Mollenhauer, H. H. and Leech, J. H., *Amer. J. Bot.*, 1960, **47**, 401.

THE HOST RANGE OF SUGARCANE ROOT-KNOT NEMATODE, *MEOLOIDOGYNE JAVANICA* (TRUEB) CHITWOOD

In an earlier report from this laboratory the occurrence of *Meloidogyne javanica* (Trueb) Chitwood on sugarcane causing root-knot was reported; the same nematode was also found on the weeds *Acalypha indica* L., *Gynandropsis pentaphylla* DC. Prodr. and *Cleome viscosa* L., and on artificial inoculation the nematode was found to infect both sugarcane and *A. indica*.¹ Further studies were made to examine the host range of the nematode and the results are reported here.

The methods of isolating the nematode from sugarcane and inoculating the test plants were the same as were used in the previous studies. Most of the plant species occurring as common weeds in the sugarcane fields in this tract were collected and grown in sterilized soil in pots. The plants were inoculated by drenching the soil with the nematode suspension obtained from the knotted sugarcane roots. Eight plants in each species were inoculated. After an interval of 40 days after inoculation the plants were pulled out and examined. First set of inoculations were made in June 1960 and such of the plant species which failed to take infection were tested again in September, 1960, using a fresh set of plants. The results obtained are summarized in Table I.

In general the infected plants developed chlorotic symptoms and so could be easily differentiated from the uninoculated ones, even without examining the roots. The degrees of severity of infection in the case of *Corchorus acutangulus*, *Eclipta alba* and *Boerhaavia diffusa* were compared by counting the number of galls on the infected and uninoculated check plants and by measuring the gall size. The results indicated that in the case of *Corchorus acutangulus* the average root length was reduced from 35.8 cm. to 22.4 cm. (37.8% reduction); there were on an average 300 galls on each plant and the size of the galls varied from 1 to 7 mm. in diameter. In *Eclipta alba* the average root length was reduced from 37.8 cm. to 20.4 cm. (46.1% reduction); there were an average of 348 galls on each plant and the gall size varied from 0.5 to 2 mm. in diameter. In *Boerhaavia diffusa* the root length was reduced from 39.3 cm. to 27.3 cm. (31.6% reduction); there were on an average of 206 galls per plant and the size varied from 0.5 to 2 mm. in diameter.

The results indicate that this nematode can infect 10 out of 21 plant species tested of which

TABLE I
The host range of *Meloidogyne javanica* from sugarcane

S. No.	Host plant		Intensity of nematode infection	Symptoms produced
1	<i>Amaranthus viridis</i> L.	..	++	Mild infection, galls on the tap roots only
2	<i>Aristolochia bracteata</i> Retz.	..	0	..
3	<i>Boerhaavia diffusa</i> L.	..	+++	Severe infection with mosaic-like symptoms on the leaves; galls mostly on the tap roots
4	<i>Cassia occidentalis</i> L.	..	0	..
5	<i>Cleome viscosa</i> L.	..	+++	Severe galling mostly on the tap roots
6	<i>Convolvulus arvensis</i> L.	..	+++	Severe infection; galls mostly on the secondary and tertiary roots
7	<i>Corchorus acutangulus</i> Lan.	..	+++	Severe infection and galls found on the tap, secondary and tertiary roots
8	<i>Croton sparsiflorus</i> Morang.	..	0	..
9	<i>Euphorbia hirta</i> L.	..	0	..
10	<i>Eclipta alba</i> Hass.	..	+++	Severe galling, more galls on secondary roots than on the tap root
11	<i>Gomphrena decumbens</i> Jacq.	..	+++	Severe galling, galls on the tap and secondary roots
12	<i>Gynandropsis penitaphylla</i> DC.	..	+++	do.
13	<i>Lippia nodiflora</i> Mich.	..	0	..
14	<i>Malvastrum coronandelianum</i> Garcke.	..	0	..
15	<i>Ocimum sanctum</i> L.	..	+	Very mild infection with minute galls on the secondary roots
16	<i>Pavonia zeylanica</i> Cav.	..	0	..
17	<i>Phyllanthus niruri</i> L.	..	0	..
18	<i>Solanum nigrum</i> L.	..	+	Mild infection on the tap and secondary roots
19	<i>Trianthema portulacastrum</i> L.	..	0	..
20	<i>Tridax procumbens</i> L.	..	0	..
21	<i>Vernonia cinerea</i> Less.	..	0	..

0 = No infection; + to ++++ = increasing intensities of nematode infection.

7 hosts were affected severely. Samad² recently reported *M. javanica* on *Ageratum conyzoides*, *Celosia argentea* and *Cleome viscosa* in Pakistan. According to Edward and Naim³ an unidentified species of *Meloidogyne* occurring in Allahabad could infect many host plants and no host specialisation was evident. In the present studies there were indications of *M. javanica* affecting only some of the plant species tested and not all of them. Also there were variations in the reaction of the different plant species to the nematode infection; in *Corchorus acutangulus* large galls were found while in *Ocimum sanctum* the galls were minute; in *Eclipta alba* galls were more on the secondary roots than on the tap root, whereas in *Corchorus acutangulus* and *Gomphrena decumbens* the galls were equally distributed on the tap root and on the secondary and tertiary roots.

Dept. of Agriculture, G. RANGASWAMI.
Annamalai University, M. BALASUBRAMANIAN.
December 12, 1960. V. N. VASANTHARAJAN.

1. Rangaswami, G., VasanthaRajan, V. N. and Venkatesan, R. *Curr. Sci.*, 1960, **29**, 236.
2. Samad, A. G., *Sci. and Cult.*, 1960, **25**, 639.
3. Edward, J. C. and Naim, Z. *Allahabad Farmer*, 1960, **34**, 9.

A NOTE ON THE CHROMOSOME COMPLEMENT OF *TRIGONOMORPHA CRENULATA* THUMB (ORTHOPTERA : TETTIGONIDAE)

SOME 24 species of the family Tettigonidae belonging to 11 subfamilies have been reported cytologically by Woolsey,¹ King,² Pearson,³ Li,⁴ Winiwarter,⁵ Favrelle⁶ and White.⁷ The present investigation of the species *Trigonomorpha crenulata* belonging to the subfamily Phaneropterinae is an addition to the eight species already noted cytologically.

A few adult male specimens were collected from the suburb of Pondicherry in May 1959. The testes were fixed in Sanfelice's fixative. Sections were cut at 18-22 μ in thickness and stained in iodine-crystal violet and Heidenhain's iron-haematoxylin with satisfactory results.

The X-chromosome is heteropycnotic and eccentrically placed during early prophase (Fig. 1). Spermatogonial metaphase plate consists of $2n = 19$ chromosomes (Fig. 2) unlike other species of Phaneropterinae where $2n = 31$. In the chromosome garniture the X-chromosome without exception lies on the peripheral position of the nucleus where other bigger autosomes

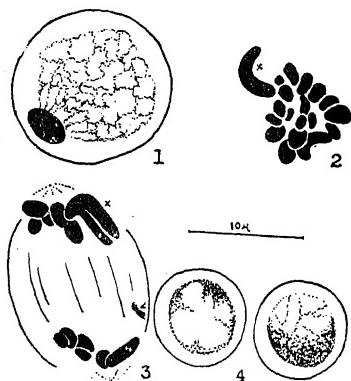
also aggregate. There are 3-4 bent chromosomes including X which seems to be mediocentric. The rest of the autosomes are rod-shaped. Broadly the chromosomes can be classified as 1 long, 9 short and 9 medium-size classes. Sex-determining mechanism seems to be $XX\text{♀}-XO\text{♂}$ type. During first division anaphase disjunction (Fig. 3) X moves to one pole indicating a reductional division for the sex chromosome.

counted; the total value represented the size of that chromosome. The mean value of each chromosome was computed from the data of 10 different nuclei and the relative percentage length of each chromosome was calculated by taking the total of the entire mean results of the chromosome complement as equal to hundred. The following data in Table I indicate the mean number of squares occupied and the percentage

TABLE I

Chromosomes	X	1	2	3	4	5	6	7	8	9
Mean No. of square	206.00	97.50	86.50	76.50	68.00	62.25	59.25	54.50	52.50	49.50
Percentage length	18.45	8.73	7.75	6.84	6.09	5.48	5.31	4.88	4.70	4.43
Chromosomes	10	11	12	13	14	15	16	17	18	
Mean No. of square	46.25	42.25	39.75	37.00	35.25	33.00	28.75	27.25	24.25	
Percentage length	4.14	3.8	3.56	3.36	3.14	2.96	2.58	2.44	2.17	

At the end of second maturation division each early spermatid (Fig. 4) resulting from two



FIGS. 1-4. Fig. 1. Spermatogonial prophase. Fig. 2. Spermatogonial metaphase. Fig. 3. First division anaphase (other chromosomes could not be traced). Fig. 4. Early spermatid.

daughter cells contains a mass of loosely broken chromatin matter. The quantitative variation of the heteropycnotic element in the two nuclei might be due to the presence or absence of the X chromosome.

A karyotype analysis by means of accurate measurements of the spermatogonial metaphase chromosomes has been made. Drawings of 10 spermatogonial cells selected at random from different slides were projected on a graph-paper with the aid of epidiascope and were traced on it. The total number of full squares ($\frac{1}{2}$ and more than $\frac{1}{2}$ squares were taken as full squares) occupied by each chromosome were

length of the chromosomes: In the graph (Fig. 5) plotted from the above data, abscissa and ordinate represent the number of squares and the percentage length of the chromosomes respectively. It indicates a clear picture of the deviation of X in magnitude with an average value of $X/A = 0.224$. Of the eight species already studied three have mediocentric X

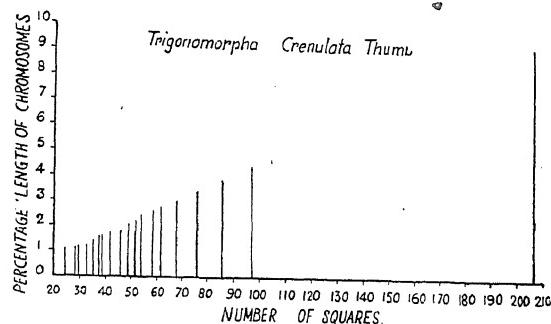


FIG. 5

chromosomes and five have telocentri ones, having the average value of $X/A = 0.157$ and 0.158 respectively. As the differences are not clearly significant, it led White (1941) to presume that the difference between mediocentric and telocentric X's in this subfamily depends solely on structural rearrangements inside the X and not on any transference of autosomal chromosome regions to the X or vice versa. But the value of X/A in the present case is so significantly great that it tends to hint at a contrary view involving an interchange of material from X-chromosome and autosomes.

The author expresses his thanks to Dr. S. G. Vengsarkar, Principal, and Dr. J. C. Saha, Professor of Biology, for the encouragement and laboratory facilities. Sincere gratitude to Dr. A. P. Kapur, Zoological Survey of India, for identification of the specimen. Thanks are also due to Dr. S. K. Lal, Professor-in-charge of Physiology, for helping with some equipment and to Miss C. V. Gracy for technical assistance.

Department of Biology J. DASGUPTA.
Medical College, Pondicherry,
October, 10, 1960.

1. Woolsey, C. I., *Biol. Bull.*, Wood's Hole, 1915, **28**, 163.
2. King, R. L., *J. Morph.*, 1923, **38**, 19.
3. Pearson, N. E., *Ibid.*, 1929, **47**, 531.
4. Le, Ju Ch'I., *Peking Nat. Hist. Bull.*, 1931, **5** (2), 1.
5. Winiwarter, H. de, *Arch. Biol.* 1931, **42**, 201.
6. Favrelle, M., *mem. Mus. Hist. Nat. Belg.*, 1936, **4** (2), 3, 53.
- *7. White, M. J. D., *J. Genet.*, 1941.

* Not seen in original.

NOTES ON SOME RECORDED AND UNRECORDED PLANTS WITH KUSMI STRAIN OF THE LAC INSECT

WATT (1901) published first the list of host plants of the common lac insect, *L. lacca* (Kerr); he enumerated 56 species as occurring in India, Burma and Ceylon. Stebbing (1910) increased this number to 88. Lately Roonwal *et al.* (1958) published a comprehensive list, recording 192 species in all. While these lists contain useful information about the various lac hosts as well as lac cultivation on them, the information as to the strain of the lac insect that thrives on these hosts is mostly lacking presumably because complete information in this regard is yet to be collected. To fill this gap, and specially to discover alternative hosts for the Kusmi strain a survey was carried out in December 1959 of the Taimara area in Ranchi Forest Division, Chotanagpur (18 miles away from Ranchi), when 12 species of plants showing lac encrustation of the Kusmi strain could be recorded. Of these, 4 species are hitherto unrecorded lac hosts, while in the case of 5 others, Kusmi strain of the lac insect has been recorded for the first time.

The species found with Kusmi lac encrustation are listed below:

- (1) *Semecarpus anacardium* Linn. (*Bhelwa*)
- (2) *Buchanania lanza* Spreng. (*Piyar*)
- (3) *Milletia auriculata* Baker (*Gai*)
- (4) *Dillenia pentagyna* Roxb. (*Rai*)

New lac host species

- (5) *Mangifera indica* L. (*Am*)
- (6) *Shore robusta* Gaertn. (*Sal*)
- (7) *Butia superba* Roxb. (*Palas lata*)
- (8) *Croton oblongifolius* Roxb. (*Putri*)
- (9) *Ficus tomentosa* (Roxb.)
- (10) *Protium serratum* Engl. (*Kandior*)
- (11) *Dalbergia latifolia* Roxb. (*Sitsal*)
- (12) *Acacia canescens* R. Grah. (*Arar*)

Species on which *Kusmi* strain is recorded for the first time

Species already known as alternative hosts for *Kusmi* strain

The area surveyed is a mixed forest having naturally occurring Kusum trees associated with different deciduous species. The Kusum trees are being already exploited by the Bihar Forest Department for lac cultivation. The above 12 species which were observed to be carrying the Kusmi lac encrustation appear to have got accidentally infected from the Kusum brood lac used for the inoculation of Kusum trees in the Aghani 1959-60 season.

Observations made in regard to the lac encrustations on these hosts are given below:—

NEW LAC HOSTS

- (1) *Semecarpus anacardium* Linn. (*Bhelwa*)
(Family—Anacardiaceæ)

Lac infection was observed on only one tree. Most of the twigs carrying lac had patchy and sparse encrustation; the lac cells, however, were well developed. Fairly heavy mortality was observed to have occurred in the early stages of the crop.

- (2) *Buchanania lanza* Spreng. (Syn. *B. latifolia* Roxb.) (*Piyar*)

(Family—Anacardiaceæ)

Only one tree of this species was found to be carrying lac. The settlement of larvae was good and fairly uniform, and larval mortality only slight. Continuous encrustation with well-developed lac cells was found on a large number of twigs. Comparatively thick shoots did not carry any lac.

- (3) *Dillenia pentagyna* Roxb. (*Rai*)

(Family—Dilleniaceæ)

Lac encrustation was found on the midrib and petiole of the leaf but not on the shoots. The accidental infection was partial and occurred only on one half of the tree. The encrustation was continuous with fairly well-developed lac cells. There were about 30 encrusted leaves, the length of encrustation varying from 2" to 6".

(4) *Milletia auriculata* Baker. (Gaj)

(Family—Leguminosæ : Subfamily—
Papilionaceæ)

Lac encrustation was found only on leaf stalks and not on shoots. The development of lac cells was quite good. Encrustations were mostly thick and continuous and 6" to 9" long. A good number of plants were found accidentally infected, of which 10 showed fairly well covered lac encrustation all over.

HOSTS ON WHICH *Kusmi* STRAIN WAS RECORDED
FOR THE FIRST TIME

(5) *Mangifera indica* Linn. (Am)

(Family—Anacardiaceæ)

Lac was found on two big branches of a tree having been accidentally infected from brood-lac bundles kept under the tree at the time of inoculation. The encrustation was mostly patchy except that a few twigs carried thick and continuous encrustations, 4" to 6" in length.

(6) *Shorea robusta* Gaertn. (Sal)

(Family—Dipterocarpaceæ)

Mostly sparse and patchy lac encrustation with good development of cells was observed on 4 trees. Nearly 30% of the shoots were covered with lac.

(7) *Butea superba* Roxb. (*Palas lata*)

(Family—Leguminosæ : Subfamily—
Papilionaceæ)

Lac was observed on three plants where approximately 25% of the shoots were covered. In some cases thick encrustation of 6" to 8" length was noted. Even the leaf stalks were seen covered with lac encrustation.

(8) *Croton oblongifolius* Roxb. (*Putri*)

(Family—Euphorbiaceæ)

Sparse as well as continuous lac encrustations were found on a good number of trees. There was lac encrustation practically on every shoot. The development of lac cells, however, was rather poor. Fairly heavy mortality at the larval stage was also observed.

(9) *Ficus tomentosa* Roxb.

(Family—Urticaceæ)

Only one tree of this species was found to be carrying lac. Encrustations were mostly patchy with scattered but well-developed healthy lac cells. Over 50% of the shoots were covered with lac.

SPECIES ALREADY KNOWN AS ALTERNATIVE HOSTS

FOR *Kusmi* STRAIN

(10) *Protium serratum* Engl. (Syn. *Bursera serrata* Wall. ex Colebr.)

(Family—Burseraceæ)

While a few trees had been accidentally infected, a few had been deliberately inoculated by the villagers. This species is known to be a fairly satisfactory alternative lac host for the *Kusmi* strain of the lac insect, particularly for growing the *Aghani* crop. Both the artificially inoculated and the naturally infected trees carried thick continuous encrustations.

(11) *Dalbergia latifolia* Roxb. (*Sitsal*)

Family—Leguminosæ : Subfamily—
Papilionaceæ)

This species is also a known alternative host for the *Kusmi* strain. Lac encrustations were observed on a number of branches of only one tree in the area. Mostly thin shoots at the apical portion were covered with thick and continuous encrustations, 3" to 6" in length.

(12) *Acacia canescens* R. Grah. (*Arar*)

(Family—Leguminosæ : Subfamily—
Mimosaceæ)

Only 2 trees had a few lac-encrusted twigs. The encrustation varying in length from 4" to 6" was thick and continuous and occurred towards the apical portion of the shoots. The cells were well developed.

In the case of all the above 12 species, the lac encrustations retained their characteristic *Kusmi* features, namely, pale colour, typical shape of the lac cells and of the encrustation. They may, therefore, be regarded as good alternative *Kusmi* lac hosts.

Divn. of Entomology, B. K. PURKAYASTHA.
Indian Lac Res. Inst., S. KRISHNASWAMI.
Namkum, Ranchi, Bihar,
December 20, 1960.

1. Watt, G., *Tachardia (Carteria) lacca* (Kerr) (Syn. *Coccus lacca*). Lac (Lakh) and the lac industries, *Agric. Ledger* (Ent. Ser.), Calcutta, 1901, No. 9, 181.
2. Stebbing, E. P., *A Note on the Lac Insect (Tachardia lacca). Its Life-history, Propagation and Collection*. (2nd Edition), *Indian For. Mem.*, Calcutta, 1910, 82.
3. Roonwal, M. L., Raizada, M. B., Chatterjee, R. N. and Singh, Balwant, *Descriptive Account of the host-plants of the lac insect, Laccifer lacca (Kerr), and the Allied Plants in the Indian Region*, Indian Lac Cess Committee, Ranchi, 1958, 140.

**NOTE ON ABNORMAL CONJUGATION
IN SPIROGYRA BRAZILIENSIS
(NORD.) TRANS.**

DURING the normal conjugation in Conjugales, fusion between one male and one female gamete is the general rule. However, cases of abnormal conjugation have been reported in many species of *Spirogyra*,^{1,2,4} *Zygnema*,² *Mougeotia*,² and *Desmids*.³ Several types of abnormal conjugations have been described in *Spirogyra* by West and West,⁴ viz., (a) by means of four tubes connecting three cells belonging to two different filaments (Fig. 1 a); (b) by means of four tubes connecting three cells belonging to as many different filaments (Fig. 1 b); (c) by means of three tubes forming a triple connection (Fig. 1 c) and (d) by means of four tubes connecting one cell of one filament and three of another filament² (Fig. 1 d). In all such

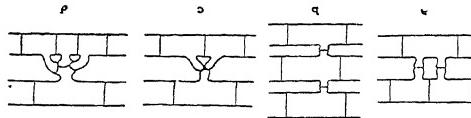


FIG. 1. Diagrammatic sketches of different types of abnormal conjugation in *Spirogyra* spp.

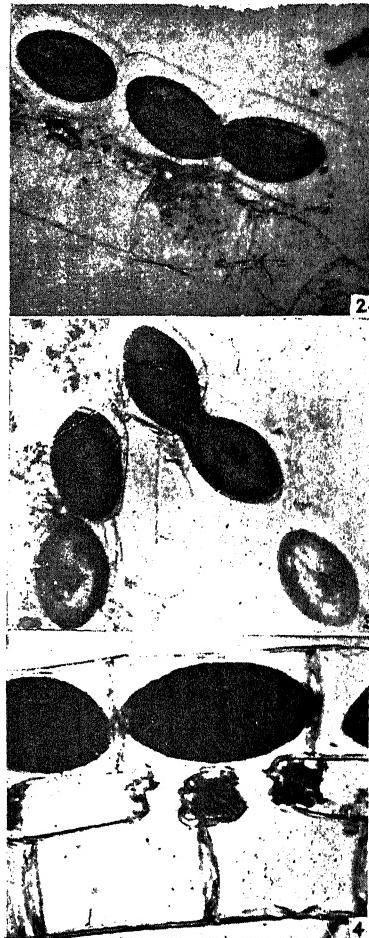
cases, the resulting zygospores are either triploids or tetraploids. Here the terms triploid and tetraploid refer to the fact that more than two protoplasts amalgamate and not to their chromosome numbers, since these observations have been made on preserved materials. Czurda² reported that when the triploid zygospores of *Spirogyra varians* and *S. lacustris* were isolated and germinated the resulting filaments did not show any morphological difference from the normal filaments.

The object of the present communication is to describe two types of abnormal conjugation in *Spirogyra braziliensis* (Nord.) Trans. collected from Moti Kund near Jodhpur in December 1952 and from Najafgarh Jhil near Delhi in December 1959.

Vegetative cells 38-45.6 μ broad and 60.2-195.8 μ long with plane walls; chloroplasts 3, making 1-3 turns; conjugation scalariform and conjugation tubes formed by both gametangia; fertile cells cylindric; zygospores ellipsoid 53.2-57 μ broad and 76-98.8 (- 106.4) μ long; median spore wall minutely verrucose; spores yellowish-brown in colour.

In the normal scalariform conjugation, conjugation tubes are formed by a male and a female gametangium, resulting in the fusion of one male gamete with one female gamete. But in

some abnormal cases, two male gametangia were found to conjugate with a single female gametangium, as a result of which three protoplasts fuse, resulting in the formation of a triploid zygospore (Fig. 4). In such cases, one cell was monopolising the energies of two cells in the opposite filament.



FIGS. 2-4. Abnormal conjugation in *Spirogyra braziliensis*. Figs. 2-3. Amalgamation of the two fused protoplasts through the dissolved cross septum. Fig. 4. Conjugation between one female and two male gametangia.

In other cases, two male gametangia conjugate with two female gametangia as in normal scalariform conjugation, but the cross septum of the female gametangium dissolves and the two fused protoplasts again fuse with each other (Figs. 2-3). Such zygospores are evidently tetraploids, because of the fusion of four protoplasts.

We are grateful to Dr. B. D. Tiagi, Shri R. M. Bhandari, Dr. M. S. Randhawa, Dr. B. P. Pal and Dr. A. B. Joshi for their interest and

encouragement and to Mr. G. S. Venkataraman for his suggestions and help.

Department of Botany, M. M. BHANDARI.
Jaswant College, S. K. GOYAL.
Jodhpur, December 7, 1960.

1. Brown, J. C., *Bot. Gaz.*, 1918, **66**, 269.
2. Czurda, V., *Conjugale in Handbuch d. Pflanzenanatomie*, 1937, **6**, 98.
3. Turner, W. B., *Kgl. Svensk. Vet. Akad. Handl.*, 1892, **25**, 1.
4. West, W. and West, G. S., *Ann. Botany*, 1898, **12**, 29.

VIABILITY AND FERTILITY OF MONOSOMICS IN *GOSSYPIUM HIRSUTUM*

AMONG plants of *Gossypium hirsutum* L. var. 320-F ($2n = 52$) grown from seeds treated with 60,000 r of X-rays, a plant with $2n = 51$ occurred. During meiosis in the microsporocytes of this monosomic plant, 25 bivalents and 1 large univalent were invariably found at diakinesis and metaphase I (Fig. 1). The mean



FIG. 1. Metaphase I of meiosis in *G. hirsutum* showing $25_{II} + 1_I$.

numbers of chiasmata per bivalent in the monosomic and normal disomic plants were 1.50 and 2.26 respectively. The univalent usually lagged and underwent division during anaphase I. The monosomic plant had smaller leaves and flowers in comparison with the control but it was more densely hairy. Though vigorous in growth, the plant was completely pollen and ovule sterile. Pollination with normal pollen and smearing the pedicels with different concentrations of auxins did not help to induce seed setting.

Stebbins¹ has pointed out that considerable differences exist among allopolyploids with regard to their ability to tolerate chromosome deficiencies. Thus, while both nullisomics and genomic substitution are tolerated by bread wheat (*Triticum aestivum*; $2n = 42$), only monosomics are viable in tobacco (*Nicotiana tabacum*; $2n = 48$). The tetraploid cotton species, *G. hirsutum* and *G. barbadense*, were until recently believed to be capable of tolerating only small segmental deficiencies but the

findings of Kammacher *et al.*² and the present report clearly indicate that in *G. hirsutum* also monosomics are viable. Unlike their counterparts in bread wheat and tobacco, monosomics of tetraploid cotton are completely sterile. The isolation of viable monosomics hence does not affect the view of Stebbins¹ that *G. hirsutum* is a more strict genomic allotetraploid than *N. tabacum* or *T. aestivum*.

The quadruple monosomic isolated by Kammacher *et al.*² in *G. hirsutum* was of spontaneous origin, while the monosomic studied by us probably arose as a result of radiation induced disjunctional abnormalities during somatic cell division. It is, however, of interest that in both instances the size of the univalents indicated that the chromosomes lost belong to the "A" genome contributed by Asiatic diploid species. No monosomics involving the loss of the New World diploid "D" genome have been found so far. A study of many more monosomics will, however, be necessary to assess the relative importance of different chromosomes in conditioning viability and fertility.

We are indebted to Dr. B. P. Pal and Dr. A. B. Joshi for their interest in this study.

Indian Agri. Res. Inst., D. JAGATHIESAN.
New-Delhi-12, M. S. SWAMINATHAN.
December 14, 1960.

1. Stebbins, G. L., *Plat. J. Genet. Pl. Breed.*, 1957, **17**, 129.
2. Kammacher, P. A., Brown, M. S. and Newman, J. S., *J. Heredity*, 1957, **48**, 135.

POWDERY MILDEW ON *GMELINA ARBOREA*

A POWDERY mildew on the leaves of *Gmelina arborea* Roxb. (Verbenaceæ), a timber tree of some importance was collected near Achalpur, Maharashtra. The fungus was a species of *Phyllactinia*. Butler and Bisby (1931) have recorded *Phyllactinia suffulta* (Rebent.) Sacc. [Syn. *P. corylea* (Pers) Karst.] on *Indigofera gerardiana* Grah., *Juglans regia* L., *Morus alba* L., *Pyrus communis* L., *P. pashia* Hom. and *Phyllactinia subspiralis* (Sal) Blum. On *Dalbergia sissoo* Roxb. Recently Ramakrishnan (1957) has described *P. heterophragmatis* from *Heterophragma roxburghii* DC. and *P. terminaliae* on *Terminalia chebula* Retz.

The powdery mildew on *Gmelina arborea* produces conspicuously larger cleistothecia than *P. suffulta*. A comparative account of various species described from India is given in Table I.

It is seen from Table I that cleistothecia on *Gmelina arborea* are conspicuously larger than

TABLE I

Species	Cleistothecia		Number	Asci	Ascospores
	No. of appendages	Diameter μ			
<i>P. suffulta</i>	..	6-12	160-230	10-30	70-100 \times 25-40
<i>P. heterophragmatis</i>	..	14-18	185-200	..	..
<i>P. terminaliae</i>	..	14-18	170-200	..	..
<i>P. from Gmelina arborea</i>	5-10	248-322	16-25	80-97 \times 24-34	28-38 \times 17-24 (35) \times (20)

P. suffulta and also differ in size of ascospores.

In *Index of Fungi* 1922-28, Petrak mentioned only one species of *Phyllactinia* and the rest being put as varieties of *P. suffulta* (Rebent.) Sacc. [*P. corylea* (Pers) Karst.] occurring on numerous hosts, distributed in different parts of the world. In his treatment of *Phyllactinia*, mostly he follows Salmon (1910) who recognized only a single species of *Phyllactinia*. Later, many workers, notably Blumer (1933), Homma (1937), Sawada (1930), Doidge (1948) have raised some of the varieties of Salmon to specific ranks. *P. erythrincæ* Doidge, *P. elegni* Lin., *P. actinidice-formosonæ* Saw., *P. mericola* Saw., *P. subspirialis* Blum. are examples of such transfers. Blumer has shown by biometric studies which have been supported by the inoculation experiments of Hommarlund (1925) that there is a greater degree of specificity among the Erysiphaceæ than have been previously acknowledged.

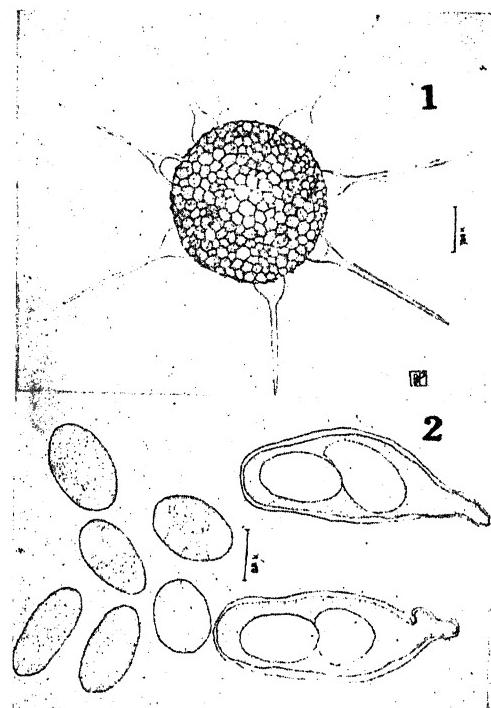
In view of the differences in morphological characters mentioned, it seems desirable to recognize the powdery mildew on *Gmelina arborea* as a new variety of *P. suffulta* with the following description.

Phyllactinia suffulta (Rebent.) Sacc. var. *gmelinæ* var. nov.

Infection spots chiefly hypophylloous, often coalescent and covering the whole leaf, upper surface showing pale-yellow colour. Cleistothecia, abundantly produced, golden-yellow to dark-brown in colour, globose to spherical, 248-322 μ in diameter; appendages in a whorl of 5-10, hyaline with a bulbous base; Asci 16-25 in number, 80-97 \times 24-34 μ ; 2-spored with golden-yellow contents; ascospores ovate or ellipsoid, 28-38 \times 17-24 μ , with orange-yellow contents.

On *Gmelina arborea* Roxb. (Verbenaceæ) Chikhaldha, Maharashtra State, 20th December 1959, Leg. B. V. Patil.

Sincere thanks are due to Dr. M. J. Thirumalachar, Superintendent, Research, Hindustan



FIGS. 1-2. Fig. 1. Cleistothecium with bulbous appendages. Fig. 2. Asci and Ascospores.

Antibiotics Ltd., Pimpri, for his keen interest, helpful criticism and encouragement. I am also indebted to Chairman, M. S. G. College, for facilities at the college laboratory and Forest Department, Maharashtra State, for assistance in the field-work.

M. S. G. College,
Malegoan (Dist. Nasik), M.S.,
December 29, 1960.

B. V. PATIL.

1. Blumer, S., Beiter. *kryptogam enfl. Schweiz.*, 1953, 7, 378.
2. Ramkrishna, T. S., Proc. Ind. Acad. Sci., 1957, 45 B, 176.
3. Salmon, E. S., Torrey Bot. Club Mem., 1900, 9, 224.

REVIEWS

Proceedings of the International Congress of Mathematicians, 1958. Edited by J. A. Todd, F.R.S. (Cambridge University Press.) Pp. lxiv + 573. Price 65 sh. net.

This volume contains the official record of the International Congress of Mathematicians held in Edinburgh in August 1958.

The introductory lists of officers, committee members and donors are followed by a record of the scientific programme, the Secretary's report, the reports of the inaugural and closing sessions, and an appreciation of the Congress's Fields Medallists. The main body of the work comprises the complete texts of seventeen one-hour and thirty-three half-hour addresses given in Edinburgh at the invitation of the Programme Committee. The one-hour addresses are designed to give broad surveys of all the major developments between 1954 and 1958. From India there is one paper on Hilbert Algebras by S. Minakshisundaram. The half-hour addresses are arranged systematically under the following headings: Logic and Foundations; Algebra and Theory of Numbers; Classical Analysis and Functional Analysis; Topology; Algebraic Geometry and Differential Geometry; Probability and Statistics; Applied Mathematics, Mathematical Physics and Numerical Analysis; History and Education.

The work as a whole, containing papers in English, French, German and Russian by mathematicians from all parts of the world, presents a comprehensive, international and up-to-date record of mathematical knowledge. The volume will stimulate further research and it can be hoped that it will serve as a focal point from which many of the results of the next few years will be derived.

V.

Some Mathematical Methods of Physics. By G. Goertzel and N. Tralli. (McGraw-Hill Book Co., Inc., 330, West 42nd Street, New York-36, N.Y.), 1960. Pp. xii + 300. Price \$ 8.50.

This book which will be welcomed by advanced students of Physics presents in a clear and consistent manner the common mathematical techniques that are used in different fields of theoretical and applied physics, such as quantum mechanics, acoustics, electromagnetic theory, and reactor physics. The book is divided into three parts. In Part I systems with a finite

number of degrees of freedom (described by matrices) are considered. In Part II these considerations are extended to systems with an infinite number of degrees of freedom, and it includes chapters on the Laplacian in one, two and three dimensions, Green's Functions, and radiation and scattering problems. Part III deals with Approximation Methods and includes Perturbation of Eigenvalues, Variational Methods and Numerical Methods. There is a useful Appendix containing the proofs of many fundamental theorems applied in the text material. At the end of each chapter are given a number of interesting problems.

The authors being teachers of experience in the subject, have developed the material in a way to suit the students' needs. , A. S. G.

Analytical Elements of Mechanics, Vol. I. By Thomas R. Kane. (Academic Press, New York and London), 1959. Pp. xv + 250. Price \$ 4.75.

This is a text-book on statics and has been written for students of the degree classes. Vector methods have been employed throughout the book and Chapter I provides an exposition of vector algebra. Each section is supplemented by a number of worked examples, and besides each chapter contains a number of problems. The book will be found to be useful to students and teachers of the degree classes.

V.

Advances in Chemical Physics, Vol. II. Edited by I. Prigogine. (Interscience Pub., New York-1, N.Y.), 1959. Pp. ix + 412. Price \$ 11.50.

Chemical physics now includes a much larger variety of topics than what was originally thought of when the term itself came into vogue nearly three decades ago. One consequence of this expansion in the scope of the subject has been that the relevant papers on the topics concerned not only are scattered among a great number of journals but are becoming increasingly terse that anyone who is not an expert in the specific field finds it difficult to follow. Hence this Interscience publication series, "Advances in Chemical Physics" edited by Prof. I. Prigogine, and containing articles of a comprehensive nature, written by experts on the subjects concerned is sure to find popular reception among teachers, students and research

workers. The first volume in this series was published in 1958. The second volume under review contains eight articles.

The first article is on Clathrate solutions by J. H. Van der Waals and J. C. Platteuw. Since the study by Palin and Powell nearly ten years ago of the "peculiar compounds" formed by hydroquinone with a large number of gases and volatile liquids, the chemistry and structure of these molecular complexes known as 'clathrate compounds' have been the subject of study by many workers. These are now known to be formed not only by hydroquinone, but also phenol and a number of related substances. In all clathrates we have a host lattice, by itself thermodynamically unstable, but which is stabilized by inclusion of a second component. Thus clathrate may be considered as a solid solution of the second component in the metastable host lattice. The article is in three parts, the first part deals with the crystal structure of the hydroquinone clathrates and of gas hydrates. The second part is devoted to a rigorous analysis of the thermodynamic behaviour of clathrates, and in the third part heterogeneous equilibria involving clathrates are discussed.

In the second article on inter- and intramolecular forces K. S. Pitzer gives a review of the theoretical methods of calculating the polarizability of molecules and the experimental data concerning the strength of the London forces in molecules. In Chapter 7, Per-Olov Lowden who himself has made significant contributions to the problem of many electron quantum mechanics gives a review of the different approaches made to obtain correlation energy in problems of molecular chemistry and discusses some of the current ideas in this field. The motions of the electrons in atoms, molecules and solids are all correlated with each other and this correlation is of two types, the first arising from the limitation imposed on the motion by the Pauli exclusion principle, and the second owing its origin to the Coulomb repulsion between the electrons. The standard method of solving the many-electron problem in quantum mechanics is by an appeal to the Hartree-Fock equations which take properly into account the exclusion principle, but owing to the use of one-electron wave functions, these equations do not adequately bring into the theoretical formalism the Coulomb repulsion between the electrons. Defining the correlation energy for a certain state as the difference between the exact eigen-value of the Hamiltonian and its expectation value in the Hartree-Fock approximation for that state, the author surveys in

this article the various methods of obtaining a measure of the correlation energy for molecules. This chapter is supplemented by an extensive bibliography.

The study of internal rotations in molecules and the forces interfering with free rotations has interested physical chemists for a long time. The potential energy barriers which come into play, although only of the order of a few thousand calories, are known to markedly influence the properties of isomers. Bright Wilson gives a review of the various methods of measuring potential barriers in the last chapter on "The problem of barriers to internal rotation in molecules". These methods include the thermodynamic method, dipole moment method, electron diffraction, infra-red and Raman spectroscopy, and micro-wave method. He also outlines the various theories of the origin of the barriers.

The other articles in this volume are : Solubility of solids in compressed gases by J. S. Rowlinson and M. J. Richardson ; Thermodynamics of metallic solutions by R. A. Oriani ; Recent advances in polymer chemistry by M. Szwarc and Nuclear quadrupole resonance in irradiated crystals by Jules Duchesne.

K. S. V.

Lehrbuchen der theoretischen Physik. By George Joos, 10th Edition. (Akademische Verlagsgesellschaft. M. B. H. Frankfurt am Main), 1959. Pp. xxiii + 842, with 212 figures in text.

The Tenth German Edition of the famous text by George Joos—perhaps the best classical book of its type—includes several additions in modern fields. The author did not survive to witness its actual publication and this edition is itself in a sense a fitting commemoration to him. As examples of the additional material, we may mention the sections of Ferro- and Antiferromagnetism, Ferro and Antiferro-electricity, and the wave-mechanical theory of the normal Zeeman effect.

S. P.

Crystal Structures, Supplement V. By R. W. G. Wyckoff. (Interscience Publishers, Inc., New York), 1960. Price \$ 26.50.

This Fifth and Final supplement recently published, completes the successful accomplishment of a monumental work undertaken by one of the world's foremost authorities on crystallography. The author has taken immense pains to make each supplement, as and when published, as up-to-date as possible. He has now, in his latest supplement, revised, expanded by addi-

tions to all the chapters, and given the final touch of fullness to his work by furnishing the Inorganic Formula Index, Mineralogical Name Index and also Index to Organic Compounds (1960). He has thus laid all crystallographers under a deep debt of gratitude.

All these five supplements and sections of the above work should find a place in the library of every Research Institute concerned with crystallography in one or other of the many aspects of the subject.

Fortschritte Der Hochfrequenztechnik, Vol. 4.
Edited by J. Zenneck M. Strutt and F. Vilbig.
(Akademische Verlagsgesellschaft, M. B. H.,
Frankfurt am Main), 1959. Pp. 321. Price
DM 42.

This book is a collection of progress reports on some of the more important problems of high frequency technique which have engaged the attention of research workers since World War II. Each report is complete in itself and has, at its end, a well selected bibliography. The reports are written in a very lucid style and give a balanced account of the present position of the topic dealt with. The contributors are all persons of real standing in the fields for which they have prepared the reports. Of the eight articles, three are in German.

The topics reviewed, the authors and the language in which it is written are as follows:—
(1) "Scatter propagation" by J. B. Weisner in English; (2) "LF and VLF propagation" by H. Poeverlein in German; (3) "Modern HF transistors" by R. H. Pritchard in English; (4) "Fabrication techniques for HF transistors" by R. N. Hall in English; (5) "Noise in semiconductors" by A. van der Zeel in English; (6) "Fluctuation phenomena in electron beams" by H. W. Konig and H. Potzl in German; (7) "Wave guide mode in a periodic delay line—a mathematical analysis with application to travelling wave tubes" by H. Poschl in German; and (8) "Getters in electron tubes" by J. S. Wagener in English.

The printing and get-up of the book are excellent. The diagrams are all neatly drawn and well reproduced. All the articles are of real value to students, teachers and research workers in physics and electrical engineering. The book should find a place not only in college and research institution libraries but also on the shelves of students and research workers.

S. V. C.

Heavenly Clockwork. By J. Needham, W. Ling and D. J. Price. (Cambridge University Press, London N.W. 1), 1960. Pp. xv + 253. Price 65 sh.

This great work is the outcome of deep researches by Dr. Needham and his collaborators into the history of science and technology in China. It was generally believed that the mechanical clock with the escapement principle was a European invention of the late 13th century A.D., and that before that time there had been only sundials, water-clocks and sand-glasses. Dr. Needham's researches have brought to light the remarkable fact that there existed a long tradition of astronomical clock-making in China between 725 A.D. and 1370 A.D. (when the art seems to have been lost) when the Chinese constructed and operated elaborate astronomical clocks powered by water and regulated by an effective form of escapement.

The key text for this discovery was the book written by Su Sung in 1090 A.D. entitled *Hsin I Hsiang Fa Yao* [New Design for a (mechanized) Armillary (Sphere) and (Celestial) Globe]. This monograph has preserved for us in unexpected detail the construction of a mechanical clock more than three centuries before the first appearance of such clocks in Europe. The following description of the 'clock' gives the ingenious technique employed in devising the escapement mechanism.

"Su Sung's 'clock' was, in fact, a great astronomical clock-tower more than 30 ft. high, surmounted by a huge bronze power-driven armillary sphere for observation, and containing, in a chamber within, an automatically rotated celestial globe with which the observed places of the heavenly bodies could be compared. Inside the tower was the motive source, a great scoop-wheel using water and turning all the shafts working the various devices. The wheel was checked by an escapement consisting of a sort of weigh-bridge which prevented the fall of a scoop until full, and a trip-lever and parallel linkage system which arrested the forward motion of the wheel at a further point and allowed it to settle back and bring the next scoop into position on the weigh-bridge.... One must imagine this giant structure going off at full-cock every quarter of an hour with a great sound of creaking and splashing, clanging and ringing; it must have been impressive, and we know that it was actually built and made to work for many years before being carried away into exile".

The book opens with a biography of that remarkable Chinese scientist-statesman Su Sung

1020-1101 A.D. but for whose monograph this outstanding research into ancient horology would have been impossible. This is followed by an interesting account of the resuscitation of Su Sung's book and its transmission to later times. A translation of the original chapter of the Chinese book on "The water-driven armillary and celestial tower" with 19 illustrations forms the fourth chapter, and the fifth chapter gives in detail the explanation of Su Sung's clock, illustrated with corresponding modern drawings.

In his book Su Sung gave not only a minute account of the stages in the construction of the clock itself but also "a historical disquisition on the instruments of similar kind which had existed in previous centuries". This had enabled Dr. Needham and his collaborators to trace the history of Chinese clock-making to the earlier centuries not only up to the seventh century A.D. but to the time of the great mathematician and astronomer Chang Heng (78-142 A.D.). These researches as well as the history of Chinese clockwork in the centuries following Su Sung's clock form the subject-matter of the sixth and seventh chapters which cover nearly half the book.

There is an interesting chapter where Dr. Needham examines the context of these inventions against the social environments of the Chinese people in the medieval ages, their customs and their superstitions. One fact that stands out foremost is that the Chinese masterpieces of medieval engineering were always connected with the Chinese imperial palace.

In assessing the imperial interest in clock-making research has thrown light on two factors. One is the practice of the issuance of Imperial calendars. The promulgation of an official calendar was one of the most important acts of the Chinese emperor. The clockwork with the powered celestial globe helped to check calendrical computation. The second, and perhaps the more interesting factor, is the one which concerned the succession to the imperial throne. It should be remembered that the Chinese emperor was a cosmic figure, and the private life of the emperor and his hierarchy of queens and consorts was regulated according to the principles of 'numinous cosmism' that pervaded Court life. Primogeniture gave no right to succession. Among the eligible heirs-apparent only he was considered as divinely ordained for the throne at whose conception the stars were in favourable positions. Hence the value of an instrument which not only told the time, but from which one could read off the star positions at any desired moment.

The book is scholarly. It keeps the interest of the reader to the end by the comments and stories concerning conditions, customs and politics in medieval China—all told in an inimitable and sympathetic style.

A. S. G.

The History of Science and Engineering in the Lands of the Orient. (United Soviet National Bureau for the History of Natural Science and Engineering, Moscow, USSR), 1960. (In Russian.) Pp. 474.

No history of science would be complete if it did not include an analysis of the contribution made by the eastern peoples. The editors of the volume under review have set upon themselves the task of tracing the history of the development and progress through ages in the fields of science and engineering in the countries of the East. The reader is impressed with the thoroughness and painstaking devotion that have gone into the preparation of the collection of articles embodied in this volume.

Of particular interest to us in India is the second part which, running to over 200 pages, gives an extensive survey of science in India and includes a bibliography of over 500 references. The chapter entitled "Water Resources and their Utilization in India" runs the whole gamut of the indigenous methods of irrigation, dams, and waterways, to the great hydroelectric projects which have come up during the Five-Year Plans of the Republic of India, as for example, the Damodar Valley Scheme, Bhakra-Nangal, Machkund, etc. There are accounts of the exchange of scientific delegations between Russia and India over the years, and sections devoted to research in the field of physics, medical conditions in India, the establishment of Indological and Sanskritic studies in the Russian Universities.

Perfumes, Cosmetics and Soaps. By W. A. Poucher, Vol. 3. A Treatise on Modern Cosmetics. VII Edition Revised. (Chapman and Hall, London). 1959. Pp. xi + 260. Price 45 sh.

The appearance of this the seventh edition of the third volume of Poucher's well-known treatise is by itself eloquent testimony to the worth and esteem in which the entire series is held by the profession. The third volume is devoted to modern cosmetics.

As usual with the Poucher volumes, this book covers a wide range of cosmetics and contains an impressive range of formulæ. These, together with the explanatory information, have

the merit of being readily found but do not always do justice to the newer and very versatile cosmetic chemicals which are finding increasing application in the industry today. In Poucher's treatment, the emphasis is on simplicity of formulation and processing rather than on modernity. Only occasional glimpses of these new trends are revealed i.e., for example, a new formula for an insoluble lipstick with tetrahydro-turtanyl alcohol, and formulation for a pre-electric shave lotion, deodorants and deodorant sticks using hexachlorophene (G. II). There is also mention of new formulas for talcum powders with G. II. It is therefore all the more surprising that there is not even a passing reference to royal jelly creams, vitamin and hormone creams, antibiotic creams and a whole host of the range which have found very wide consumer acceptance.

More glaring however is the total omission of any reference to pressurised packs and aerosols. The latter is all the "rage" in the United States, very popular on the Continent, Japan and Australia and have made great strides even in the rather conservative United Kingdom. Indeed, there are experts who aver that pressurised packs and aerosols would extend their sway in the cosmetic world of tomorrow. It is to be hoped that an entire chapter would be devoted to these topics in the next edition of this useful book.

These limitations do not detract from the worth of this volume as a whole and the mass of data actually presented with care and precision. This book, together with its two predecessors, would pretty rank as the *magnum opus* from one of the tallest figures in the British cosmetic and perfumery world.

M. N. SUBBA RAO

General Zoological Microtechniques. By Francis M. Weimer (William & Wilkins Co., Baltimore), 1960. Price \$3.25.

A thorough training in microscopic techniques at the graduate level is a prerequisite for students hoping to take up a research career. This book embodies the experience gained by the author during a period of ten years in handling such a course at the University of California, Berkeley. "There is no 'universal technique' which will work equally well for all materials, nor unfortunately, for all technicians". The descriptions and exercises deal with 'classical techniques' which have stood the test of time and detailed directions as to how the material should be handled are given.

Students learning micro-techniques would find this book valuable. M. K. SUBRAMANIAM.

Books Received

Introduction to Quantum Mechanics. By R. H. Dieke, J. P. Wittke. (Addison-Wesley Pub. Co., Reading, Mass., U.S.A.), 1960. Pp. xi + 369. Price \$8.75.

Grazzae of Burma, Ceylon, India and Pakistan. (Excluding Bambaceae). By N. L. Bur. (Pergamon Press Ltd., Headington Hill Hall, Oxford), 1960. Pp. xviii + 767. Price £8.

Cambridge Monographs on Mechanics and Applied Mathematics The Rotation of the Earth A Geophysical Discussion. By W. H. Munk and G. J. F. MacDonald. (Cambridge University Press, London N.W. 1), 1960. Pp. xix + 323. Price 70 sh.

Qualitative Organic Analysis. By B. Haynes. (Cleaver Hume Press, 31, Wright's Lane, Kensington, London, W. 8), 1961. Pp. 239. Price 17 sh. 6 d.

Cytogenetics and Plant Breeding. By N. Krishnamoorthy and S. N. Chandrasekharan (P. Varadachari & Co., Madras-1), 1960. Pp. xv + 653. Price Rs. 25.

Pure and Applied Mathematics (Vol. X) Lectures on Differential and Integral Equations. By K. Yosida. (Interscience Pub., New York 1, N.Y.), 1960. Pp. ix + 290. Price \$7.00.

Indian Tobacco A Monograph. (Indian Central Tobacco Committee, Madras-6 ; The Business Manager, I.C.A.R., New Delhi-2), 1960. Pp. xv + 413. Price Rs. 36.

Interscience Tracts on Physics and Astronomy An Introduction to Celestial Mechanics. By Theodore E. Sterne. (Interscience Pub., New York), 1960. Pp. xi + 206. Price \$4.50. Cloth Bound ; \$2.50 Paper Bound.

Space Flight Technology. Edited by K. W. Gatland. (Academic Press, Inc., 17 Old Queen Street, London S.W. 1), 1960. Pp. xv + 365. Price 75 sh.

Advanced Euclidean Geometry An Elementary Treatise on the Geometry of the Triangle and the Circle. By R. A. Johnson under the Editorship of J. W. Young. (Dover Publications, New York), 1960. Pp. xiii + 314. Price \$1.65.

Symposia of the Society for Experimental Biology, No. XIV Models and Analogues in Biology. (Cambridge University Press, London N.W. 1), 1960. Pp. vi + 255. Price 50 sh.

SCIENCE NOTES AND NEWS

Double Phlox

Dr. P. C. Tandan, Civil Surgeon, Shahjahanpur, writes :

Last year a variant Phlox Drummondii flower with a central tuft of small and rudimentary petals arising from the upper end of the corolla tube was noticed. By a process of cross-pollinations it was desired to observe if this variant characteristic (which could as well be mutant) was transmitted to the second generation.

A large number of variants have been observed and out of more than 300 specimens which have been examined so far, the most outstanding is the one which has got a central tuft of petals (see Fig. 1). This change has been observed



Fig. 1

in several plants raised from the seeds produced last year by the pollen from the variant flower. The transmission of the characteristics to the second generation suggests mutation. Observations and experiments are being continued to see if this characteristic becomes fixed in the next generation.

Award of Research Degree

Gujarat University has awarded the Ph.D. Degree in Physics to the following students of the Physical Research Laboratory, Ahmedabad, for the theses noted against their names :—

- (1) Shri S. R. Sreenivasan, "The distribution of electrons in the ionosphere from vertical soundings";
- (2) Shri U. R. Rao, "A study of time variations of cosmic rays with directional telescopes at Ahmedabad";
- (3) Shri H. S. Ahluwalia, "The study of time variations of cosmic rays at low and intermediate latitudes";
- (4) Shri R. V. Bhonsle, "Studies in ionospheric physics using extra-terrestrial radio-noise".

Symposium on History of Sciences in India

A Symposium on the History of the Development of Sciences in India will be held on August 4 and 5, 1961, in Calcutta.

The Symposium will cover the following broad fields of scientific developments in Ancient and Mediæval India : (a) Mathematics, Astronomy, Physics and Earth Sciences ; (b) Chemistry, Applied Chemistry and Technology ; (c) Medicine, Health, Biology and Agriculture ; (d) Social and International Relations in the Development of Sciences ; Teaching of the History of Sciences.

Further particulars can be had from Dr. A. C. Ukil, Convener, History of Sciences Board, National Institute of Sciences of India, Calcutta-16.

Indian Pharmaceutical Congress Association

The following were elected as Office-bearers of the Indian Pharmaceutical Congress Association for 1961-62. President : Dr. B. Mukherjee, Lucknow; Hon. Gen. Secretary : Dr. D. Chakravarty, Calcutta; Foreign Secretary : Dr. P. L. Seth.

International Society for Tropical Ecology—1962 Symposium

In response to the suggestion made at the first symposium on "Ecological Problems in the Tropics" held in Allahabad on February 3-5, 1961, the Society proposes to hold the second symposium in 1962, the place and the dates for which will be announced in due course and will be intimated to those who respond to this circular. The subject chosen for the 1962 symposium is "The Evaluation of Tropical Habitat for Production of Food, Fodder, Fuel and Fertilizers". Papers are invited on any of the topics coming under the above general heading. Abstracts of papers should be sent to the Gene-

ral Secretary by the 15th August and the full papers by November 1961. For further particulars please write to Dr. G. S. Puri, General Secretary, 10, Chatham Lines, Allahabad.

Salt Pseudomorph Shales from the Upper Vindhyan of Maihar-Rewah Area

Shri R. C. Misra, Department of Geology, Lucknow University, Lucknow, writes: During a visit to the Maihar-Rewah area, Madhya Pradesh, in December 1960, where an almost complete sequence of Lower and Upper Vindhyan are exposed, an array of beautifully preserved sedimentary structures was discovered. These consist of salt pseudomorphs, rain prints, pebble mark, worm track, flow-cast, drag folds in Sirbu shales; algal, boudinage, box-work, penecontemporaneous and swash mark structures in Bhander limestone; flute casts in Rewah shales and rill marks in Rohtas shales.

The presence of salt pseudomorph shales in the Sirbus is of considerable importance to Vindhyan Geology. Such shales were so far known only from the Cambrian sequence of the Salt Range (Pakistan). The correlation of the Vindhyan sandstones has been done with the purple sandstones of the Salt Range. The present discovery strengthens this correlation.

Annular Low Pressure Mercury Lamp

The many advantages of using low pressure mercury lamps for exciting Raman spectra are well known. Each laboratory has its own type of low pressure lamps to suit the nature of the investigation in hand. A horizontal annular type with two liquid-mercury electrodes separated from the active discharge region is described by two Russian scientists, Kondilenko and Vorobeva (*Optics and Spectroscopy*, 1960, 9, 273). The lamp is easy to make. Its high light output and good spectral properties, combined with the uniform and stable illumination it provides, make it specially suitable for routine qualitative and quantitative Raman spectra analysis.

The lamp consists of two coaxial cylinders, made of molybdenum glass, with diameters 30 and 70 mm., the annular clearance (the discharge region) between the walls being 20 mm. Tubular outlets are fused onto the opposite ends of the lamp for the electrodes (25 mm.) which are cooled internally with running water. The length of the working part of the lamp is 200 mm, the distance from the cylinder to the electrodes is 80 mm. A supplemental mercury electrode is provided near the cathode to facilitate ignition. After the ignition arc has burned

for a few seconds, and the cooling of the electrodes has begun, the lamp is ignited readily by touching the glass surface of the electrode vessel with the discharge from a small high frequency generator (80 kc.). The lamp is fed from 110 volt dc power supply. It works steadily from 6 to 25 amps. and working at 16 amps. is recommended for normal work.

To obtain Raman spectra, the cuvette with the substance under investigation and the cooler are inserted in the inner cylinder. Coating the outer cylinder with magnesium oxide and blackening the farther end of the lamp, help to increase the light falling on the experimental cuvette and avoid stray scattering in the direction of observation. With a fast spectrograph (ISP-51), a satisfactory Raman spectrum of CCl_4 showing the anti-stokes components, also could be obtained in 15 seconds.

The Double-Pass Jamin Interferometer

In a paper contributed to the *British Journal of Applied Physics*, Hariharan and Sen, of the National Physical Laboratory, Delhi, have discussed the application of the principle of three-beam interference to obtain increased accuracy in measurements of small angular displacements. They have also described a modified three-beam interferometer for small angular measurements.

When the rays emerging from a Jamin interferometer are reflected back through the instrument, fringes similar in appearance and behaviour to three-beam fringes are obtained. These fringes can be used to measure small angular displacements of one of the beam-dividing plates with an accuracy of $0.01''$.—(*British J. App. Phys.*, 1961, 12, 20).

Interplanetary Magnetic Field and the Auroral Zones

The discovery of a regular interplanetary magnetic field by space probes (like Pioneer V) has reawakened interest in Hoyle's suggestion that the primary auroral particles are accelerated at neutral points in the combination of an interplanetary field and the geomagnetic field. Hoyle pointed out that the latitude of the aurora would depend on the distance of the neutral points from the earth and hence on the interplanetary field strength in the observed sense.

In a letter communicated to the *Physical Review (Phys. Rev. Letters*, 1961, 6, 47) J. W. Dungey considers a model with interplanetary plasma moving relative to the earth, this "wind" lying approximately in the ecliptic plane, and an interplanetary field pointing roughly southward. On this model the connection between

the neutral points and auroras becomes obvious. The model predicts an asymmetry for auroras : for a "wind" from the sun there should be proton auroras before midnight and electron auroras after midnight. Recent results from IGY data are of great interest in connection with the model presented here and promise substantial advances in our understanding of the subject.

Acoustic Radiation by Insects

Reporting on the source of energy responsible for acoustic radiation by insects, Prof. Wigglesworth of Cambridge said that in the case of the common midge which emits a frequency of about 1000 cycles, the frequency is controlled by elasticity and inertia of the muscles of the animal's body. The power output is due to enzymes working on fats or sugars, which can release energy at the rate of about 500 calories per gram of muscle per hour. This is greatly in excess of the power production of the muscles in man.—(*J. Acous. Soc. Amer.*, 1961, 33, 98).

Structure of Vitreous Ice

Investigations using such techniques as thermal analysis, electron diffraction, and X-ray diffraction have shown that there are three possible phases of ice at low temperatures and pressures, namely, hexagonal (usually called ice I), diamond cubic, and vitreous. X-ray diffraction studies have shown that the hexagonal model is built up of layers of oxygen atoms, each layer consisting of a network of open puckered hexagonal rings. Each additional layer is a mirror-image of the preceding layer, so that the stacking is of the A.B.A.B.... sequence. The cubic model also may be considered as being built up in layers of oxygen as above, with the modification however that each successive layer is shifted one-half the diameter of the hexagonal ring, leading to the A.B.C.A.B.C.... stacking sequence typical of the diamond cubic system.

Results of recent investigations by X-ray diffraction method reported by Dowell and Rinfret throw some light on the structure of vitreous ice (*Nature*, 1960, 188, 1144). They

have studied the temperature ranges in which the various phases exist and the rates of transformation from one phase to another. They have been able to produce vitreous ice only by condensing water vapour on a surface maintained below -160°C . This vitreous ice undergoes a partial and irreversible change to cubic ice at temperature above -160°C , the rate of transformation being strongly dependent on temperature. The mixed cubic-vitreous phase undergoes an irreversible transformation to hexagonal ice I at temperatures above -130°C , the rate again being temperature-dependent.

The X-ray diffraction pattern of vitreous ice is characterized by two intensity maxima, one at 24° (2θ) corresponding to a Bragg spacing of 3.71 \AA and the other at 42° corresponding to 2.15 \AA . These results show that the structure of vitreous ice is different from that of water at ordinary temperature. Also it is to be noted that attempts to produce vitreous ice directly from liquid water prove unsuccessful, and the condensation of pure water vapour is the most reliable and practical method of producing vitreous ice.

The observed results on the diffraction patterns and rate transformations may be explained on the basis that in vitreous ice domains exist in which there is a tendency toward the same layer structure present in the crystalline phases, although with random distribution of molecules within the layers. Those domains having very nearly the same layer spacing as the crystalline phases are apparently quite stable, but those having greater disorder are unstable. At temperatures above -160°C , crystallization to the cubic phase begins spontaneously at a few sites in the unstable zones, and the crystallites at each site quickly grow to about 400 \AA , where further growth is hindered by the more stable zones. Further crystallization takes place at new sites in the unstable domains, the process continuing until all such areas have crystallised. This state is now stable at all temperatures below -130°C . Above -130°C , both the cubic and the remaining vitreous ice begin to show conversion to the stable hexagonal phase, the individual crystallites growing to moderate size, about $10\text{ }\mu$.

179-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, *Current Science Association*, Bangalore-6.

Subscription Rates : India : Rs. 12-00.

Foreign : Rs. 16-00 ; £ 1-4-0 ; \$ 4.00.

DOUBLE STAR ASTRONOMY*

DOUBLE star astronomy has always played a major part in the development of astrophysics. Its importance lies in the data it provides in formulating a consistent theory of stellar evolution. The ultimate problem of the study of binary stars is to gain an understanding of the cosmic processes which led to their formation, or which may control their astronomical future. As early as 1902, A. W. Roberts in the pioneer days of double star astronomy wrote: "the study of Algol variables should bring us to the very threshold of the question of stellar evolution, and to the heart of not a few of the greatest cosmical problems". The evolution of stars constitutes a process so slow when measured in terms of human time-scales that no changes arising from it can become perceptible within the brief period of a few centuries over which the subject has been studied. Hence the only method of testing theories of stellar evolution that have been propounded from time to time is to compare the theoretical deductions with the observed statistical properties of different types of stellar populations. The success of such tests will naturally depend on the range of information that can be gathered from observations of the various stellar types. In this context double star astronomy plays a unique role in that there is no other branch of practical astronomy which can supply such a wealth of data as can be obtained from detailed studies of close binary systems, especially of the eclipsing type. Close binaries are not a rare phenomenon either. At least seven eclipsing variables are known within 30 parsecs from the Sun, and as this volume contains some 3,000 stars, eclipsing binaries constitute about 0.2%, and the total number of binaries for all values of celestial inclinations may be in the neighbourhood of 1%, that is, in our galactic system as a whole the number of close binaries may be estimated as of the order of 10^9 .

As a result of systematic work on the orbital and other characteristics of close binary systems in the galaxy many unexpected and exciting results have emerged. One such is Kuiper's deduction that the solar system is a degenerate double star in which the second mass did not condense into a single star but was spread out, and formed planets and comets. Another recent

advance is the finding of Struve that close binaries interact not only dynamically but also physically and that there is frequently an interchange of matter from one star to its companion. These results together with the fact which recent studies have fairly well established, namely, that many of the very close binaries are evolving, so to say, right before our eyes, have made the study of close binary systems a subject of paramount importance in contemporary stellar astronomy. Visual binaries are sometimes separated by hundreds—often thousands—of astronomical units (AU, distance of Sun from the earth), so that several generations of astronomers are needed to observe even a small part of their orbital motion, but close binaries may make thousands of revolutions in a comparatively short time. For example, the binary star UX Ursæ Majoris completes one revolution in 4 hours 43 minutes, the shortest known period among binaries. The great significance of many short-period systems is that they give evidence of physical change taking place during the microscopically short lifetime of an astronomer, and there is some chance of his studying at least a small portion of the life-history of this type of stars. Such stars may truly be said as the astronomers' *drosophilæ*.

The term binary star was first used by Sir William Herschel in 1802, to designate a real double star which is "the union of two stars that are formed together in one system by the laws of attraction". It is to be distinguished from what is popularly referred to as "double star" to describe a close pair of stars which are really different in distance and age, having no physical connection, and owe the proximity of their projections on the celestial sphere only to the laws of chance. Double star systems vary widely both as regards their period, and the separation of the components. Their periods range from a few hours to about 10^7 years. As regards separation, there are pairs in which the components are almost in contact (contact binaries), and those in which the separation is of the order of 44,000 AU.

Binary systems are of two types: (i) wide (or visual) binaries which are resolvable through a telescope, and (ii) close binaries, which although they are not resolvable by telescopes, may yet be identified as binaries either (a) by the periodic variation of intensity (eclipsing binaries), or (b) by observing spectroscopically the Doppler shift due to varia-

* *Close Binary Systems*. By Zdenek Kopal. International Astrophysical Series, Vol. V. (Published by Chapman and Hall, Ltd.), 1959. Pp. xvi + 558, Price 105 sh.

tion in their radial velocity (spectroscopic binaries). Both eclipsing and spectroscopic binaries belong to the same physical group and differ in their observable manifestations only by an accident of orientation of their orbits in space.

Wide binaries are of limited interest from the point of view of getting information; for apart from their mutual attraction which makes them to revolve in closed orbits around their common centre of gravity, the components do not influence each other in any other way, but behave, and probably also evolve, like single stars in space. The distance between wide binaries are very large compared to their stellar diameters. With increasing proximity, however, there will be mutual dynamical interaction between the two, and distortions and perturbations of significance will arise from tidal actions and axial rotations. The shape of the individual components will depart from a sphere, and provided that the free oscillations of the components are sufficiently short in comparison with the period of the orbit, the appropriate distortion of both will be governed by the equilibrium theory of tides, i.e., the component stars will be distorted ellipsoids.

In interpreting the observed changes in the brightness of close binary systems, the effects of the distortion will have to be taken into account. Since the components of the eclipsing binaries are distorted ellipsoids with their longest axes constantly in the direction of the radius-vector, their apparent area—and, therefore, the light—as seen from the earth should vary continuously in the course of a revolution (*ellipticity effect*). It will also happen that part of the radiation of each component will fall on the other where it will be absorbed and re-emitted in all directions. This produces the *reflection effect*. These effects in the intensity of the light from close binaries will be in addition to, and independent of the light changes which arise from eclipses. The theoretical distribution of brightness over their apparent discs as seen by a distant observer can be deduced from the laws of limb-darkening and gravity-darkening as shown by Chandrasekhar. It may be noted that the limb-darkening tends to make brightest those parts of the visible surface which are nearest to the observer, the gravity-darkening those which are nearest to the star centre. The theory of the determination of the orbital elements of close binary systems from the properties of the photometric light curves, developed by Russell and Shapely, has enabled astronomers to estimate the sizes and shapes of

component stars, as well as their luminosities and separations. Because many factors influence the shape of the light curve, complete analysis is often difficult.

It is in this particular field of investigation that Prof. Kopal, the author of the book under review, has made many significant contributions, and so the book is authoritative on the subject. It gives first-hand knowledge of the methods by which photometric and spectroscopic observations of close binary systems can be analysed to yield all possible information about their components. After the first introductory chapter, Chapter II deals with the general dynamics of close binary systems. Chapter III discusses the geometrical analysis of the Roche model or the centrally condensed model in which the components of the system are represented, for gravitational purposes, by two mass points. The importance of this model and the significance of what is shown as the Roche limit, in the author's theory of the evolution of binary systems, have been brought out clearly in a later chapter. Chapters IV and V contain a systematic development of the theoretical light-, and radial velocity-curves exhibited by distorted rotating components of close binary systems, between minima, as well as within eclipses. Chandrasekhar's elegant proof of von Zeipel's theorem relating to radiation flux in distorted stars is included here.

The most important chapter in the whole book is Chapter VI which covers nearly a third of the book. It deals with the determination of the elements of eclipsing binary systems from an analysis of their observed light changes. As mentioned already, the author himself is noted for his many contributions in this branch of the subject and, in fact, the contents of this chapter are largely a consolidated account of these contributions in what is known as Kopal's iterative methods, as opposed to the well-known direct method developed by Russell and Shapely. The concluding Chapter VII is on physical properties of close binary systems, and in the last section of this chapter the author, taking stock of all the known facts of binary systems, explains what they reveal concerning the origin and evolution of binary stars.

The origin of close binary systems is no doubt to be sought in the same general processes which lead to the formation of stars. The accepted theory is that the stars originate by a gravitational collapse of cosmic gas-clouds containing enough mass to give birth to hundreds or thousands of individual stars at the same time. Close binaries were formed

simultaneously with single stars as by-products of essentially the same formative process. It is also evident that the chemical composition of the two components in each pair was initially the same at the time of formation. Their masses, however, were different and this has made all the difference in their subsequent evolution. The story of this evolution contains—

ing new ideas is told in the last chapter of the book.

This volume amply fulfils the main purpose of the International Astrophysical Series, which is to provide an authoritative account of the subjects in a manner to assist their teaching and advancement.

UNITED STATES' SUCCESS IN MANNED SPACE FLIGHT

A NOTABLE success in space flight was achieved by United States when on May 5, 1961, it sent a man into space and recovered him safely. The astronaut was 37-year old Commander Alan Shepard of the United States Navy. The space capsule in which Shepard rode was 6 ft. x 9 ft., a little bigger than a telephone booth, and weighed about one ton. It was blasted into the sky in the 66 ft. Redstone rocket from the missile base at Cape Canaveral, Florida, at 9.34 a.m. (14.34 GMT) on Friday, May 5, 1961. The capsule soared in a vast ballistic arc over the Atlantic and plummetted into the sea inside a ring of recovery ships just fifteen minutes later. Shepard climbed out of the capsule unaided and was winched to safety by a marine helicopter which landed both astronaut and capsule on the deck of the recovery ship, the aircraft carrier Lake Champlain stationed 290 miles downrange from the site of launching. The historic flight was the climax of two and a half years' work and 400 million dollars expenditure. It closely followed Russia's success in the first manned space flight just 23 days previously when on April 12, Major Gagarin orbited the earth once round in his 108-minutes flight in the space ship Vostok (see *Curr. Sci.*, April 1961).

The essential details of the US space flight have been reported as follows: The weather this morning was fine and Shepard was driven out to the launching pad in a van. His aluminised space suit gleamed in the glare of the arc lights as he squeezed through the tiny hatch of the capsule and wriggled on to the specially contoured couch. Shepard was sealed in the capsule at 6.10 a.m. (11.10 GMT). At blast-off, flame leaped from the base of the rocket and it began to lift into the air with a shattering roar, ponderously at first, then with gathering speed. Shepard was forced deep into his form-fitting couch by the fierce gravitational pull as the rocket vanished into the clouds and accelerated to a speed of over 4,000 miles per hour in a few seconds. Shepard's voice crackled into the tense control room. His first words were—"what a beautiful view".

From then on, he reported continuously to the control room on how he felt and the behaviour of the rocket. He spent much of the flight with his eyes shut, reading the instruments by touch, as he fought the massive strain of 11 G.—eleven times the force of gravity. Subsequently Shepard reported: "I am now experiencing six G's-, five G's-, four G's-.

The capsule separated from the rocket when it was 90 miles up, and Shepard took over manual control of the capsule and performed basic manoeuvres in different directions. He performed a roll successfully. He reported he had fired the retro-rockets to slow down the capsule before it plunged into the Atlantic. After being weightless for several minutes, Shepard prepared for the critical re-entry into the earth's atmosphere. He talked to recovery ships. Moments later slowed by the retro-rockets, the capsule decelerated further as Shepard opened his secondary parachute. Then the great red and white main parachute opened and watchers on the recovery ships saw the capsule for the first time as it drifted down to the Atlantic. A landing bag beneath the capsule inflated to cushion the fall when the capsule hit the sea 80 miles north-west of Grand Bahama island and three miles from the aircraft carrier Lake Champlain. Shepard climbed out of the capsule as a marine helicopter swooped down on him. Three minutes later he was aboard the helicopter, which also winched up the capsule.

An official announcement by the National Aeronautics and Space Administration (NASA) said: "The Project Mercury spacecraft carrying astronaut Alan Shepard on the nation's first manned flight landed on the Atlantic Ocean about 302 statute miles from here at 9.49 a.m. E.S.T. The altitude was about 115 miles, the speed about 5,100 miles per hour. The sub-orbital flight required 15 minutes. Preliminary data show the pilot performed satisfactorily during flight." The blast-off time was officially announced as 9 hours 34 minutes and 13 seconds a.m.

SEISMIC EXPLORATION IN THE KARAIKAL-NAGORE AREA OF THE CAUVERY BASIN, MADRAS STATE*

L. N. KAILASAM

Geological Survey of India

GRAVITY and magnetic surveys of the coastal sedimentary belt of Madras State were started by the Geological Survey of India in 1954 with a view to investigate the thickness of the marine sediments and their stratigraphic and structural disposition for assessing the possibilities for petroleum in the area and to locate additional hidden lignite deposits, if any. An account of the investigations carried out in the coastal areas of South Arcot District by the author was published in *Current Science*, 1958, 27, 476. Subsequently, an east-west reflection seismic traverse, extending from the crystalline outcrops to the west of Vriddhachalam town to Porto Novo on the sea coast across the sedimentary belt, was conducted along the Vriddhachalam-Bhuvanagiri-Porto Novo highway. The seismic data have indicated a thickness of the order of 9,000 feet over the sea-coast near Porto Novo, which is quite encouraging from the point of view of petroleum occurrence, adding significance to the gravity 'highs' outlined earlier immediately to the south of Porto Novo as also to the north.

The gravity and magnetic surveys have since been extended southwards across the Coleroon and Cauvery Rivers, and a major part of the Cauvery basin covering an area of roughly 4,000 square miles in the Tanjore District has been surveyed by gravity and magnetic measurements by Y. R. Bhanumurthy and party under the direction of the author.

The geological features of this coastal sedimentary belt have been described by a number of geologists in published papers. A brief summary of the same has also been furnished in the author's earlier paper referred to above. The widest portion of the coastal sedimentary basin lies in the Tanjore District including the off-shore part in the Palk Straits. Most parts of the Cauvery basin in the Tanjore District are covered by Cuddalore sandstones of Miocene age. These consist of grits, pebble beds, argillaceous sandstones, clays and sands. Some poorly developed exposures of the marine Cretaceous can be seen a few miles to the west of Tanjore town. The presence of salt and gypsum in the earliest strata of the

Cretaceous afford evidence of desiccation in an enclosed basin.

Eocene sediments have been encountered in a number of deep bore-holes sunk for ground water both in the South Arcot and Tanjore parts of the sedimentary belt, underlying the transgressive Miocene (Cuddalore) formations. The Eocene rocks have been reported to consist of clays, soft shales and limestones with abundant micro-fossil content. The bore-holes, some of which have been taken to depths of 1,500 feet, have so far indicated a thickness of more than 800 feet for the Eocene strata.

Exposures of Upper Gondwana rocks consisting of sandstones, grits and micaceous shales are seen near Uttattur in the Trichinopoly District and near Sivaganga in the Ramanathapuram District, but these exposures do not occur in the Tanjore District. These rocks, being of terrestrial and fluviatile origin, have no significance from the point of view of petroleum occurrence.

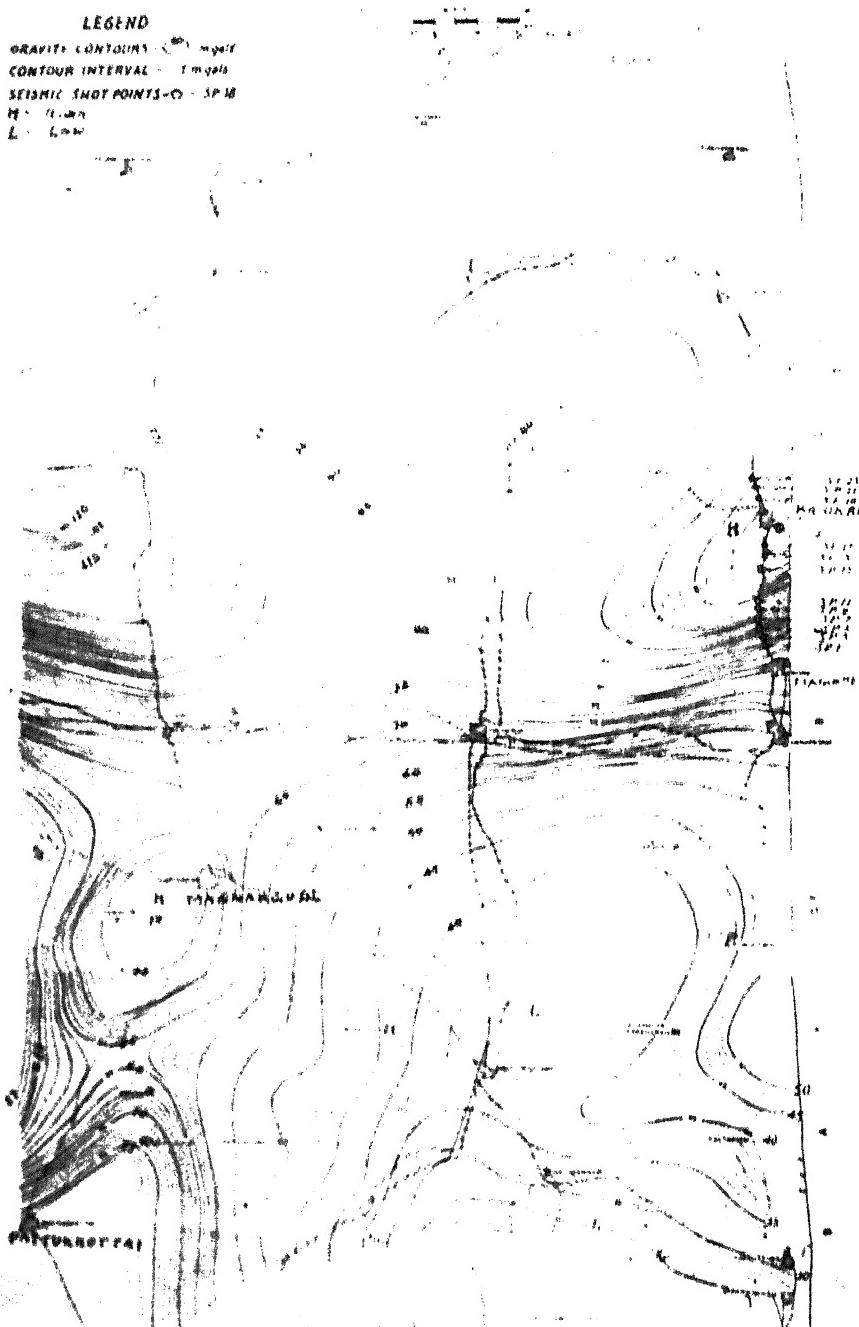
The Bouguer gravity map of the eastern parts of the Cauvery basin is shown in Fig. 1. It may be noted that a prominent gravity 'high' is indicated in the Karaikal-Nagore region, which has also been corroborated by a magnetic 'high'. This feature extends partly into the sea, but the nature of the indication suggests a definite closure. In order to obtain precise information regarding the thickness of the sediments for interpreting the gravity and magnetic data, it was decided to run a test seismic traverse in the Tanjore District of the Cauvery basin as was done in the South Arcot District to the north of the Coleroon River. The test traverse was conveniently taken over the sea-coast in a north-south direction along the Nagore-Karaikal-Tranquebar road across the gravity feature. This structural feature may be designated as the 'Karaikal Structure'.

The various seismic shot points are indicated in Fig. 1 and the seismic time-section is shown in Fig. 2. A number of clear and well defined reflections have been brought out in the seismograms (Fig. 3) with two-way times of roughly 0.55, 0.75, 1.08, 1.55, 1.68, 1.85 and occasionally more than 2.0 seconds. The two-way times, plotted after the necessary reductions, are shown in Fig. 2. The time-section indicates clearly a marked reversal of dip in the north-south

* Published with the kind permission of the Director, Geological Survey of India.

LEGEND

GRAVITY CONTOURS (in mgal)
CONTOUR INTERVAL = 1 mgal
SEISMIC SHOT POINTS - O - SP 18
H = HIGH
L = LOW



direction, confirming the gravity indication. The reversal of dip is indicated practically in all the reflecting horizons. The marked reversal of dip in the north-south direction is also clearly discernible in the seismograms for shot points 2 and 20 reproduced in Fig. 3.

The Karaikal structure appears to be significant and important both in respect of its size and nature regarding its petroleum possibilities, and a test drill-hole may advantageously be put down at a point very near Karaikal town (Fig. 1), after outlining the structure fully with

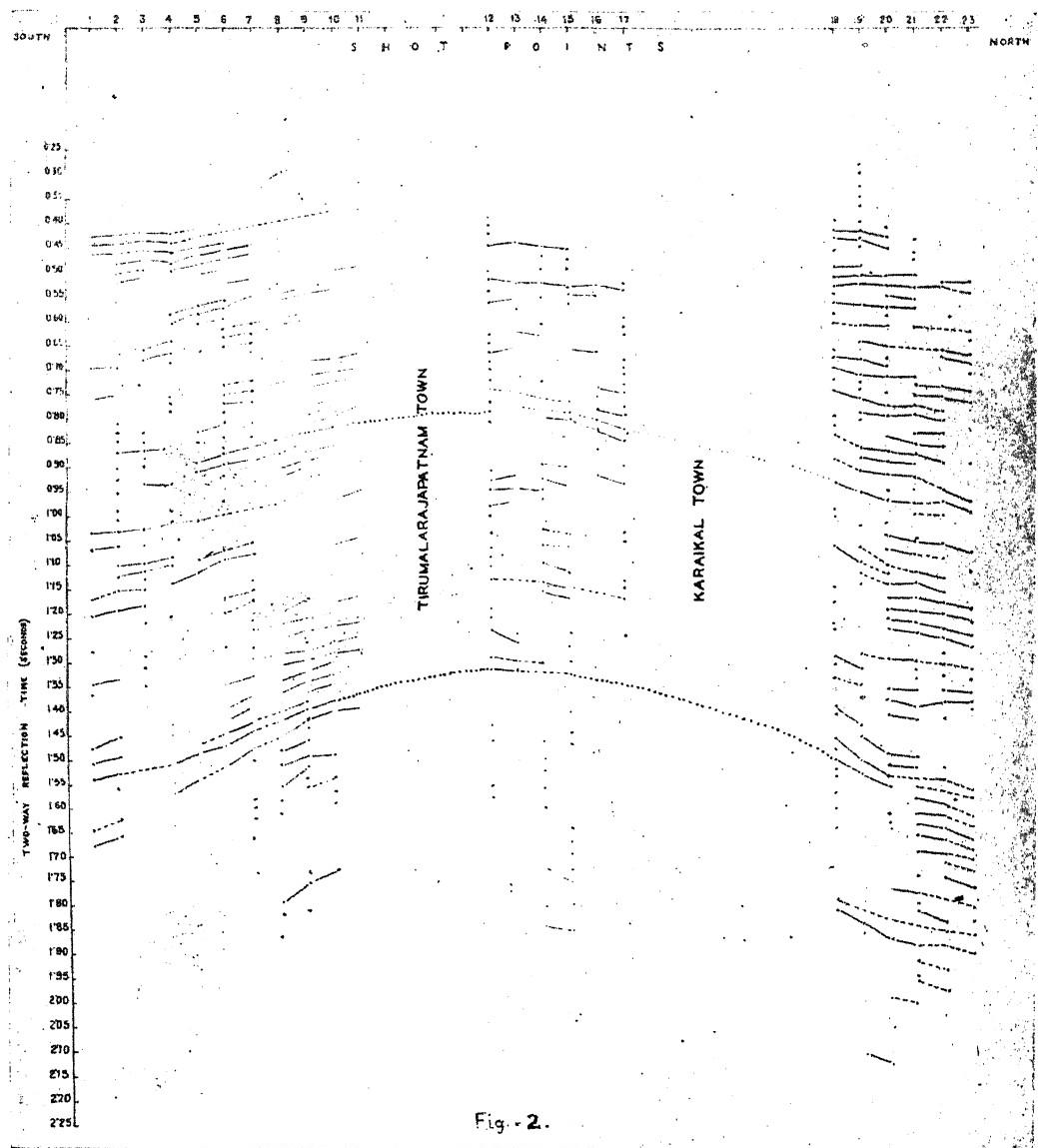


Fig. 2.

The seismic data also indicate a thickness of the order of 9,000-10,000 feet for the sediments in the coastal areas near Karaikal, which is more or less of the same order of thickness indicated in the Porto Novo area in the South Arcot District.

the aid of additional seismic profiles with some off-shore observations over the portion of the feature extending into the sea. This incidentally indicates the scope for off-shore exploration for oil near the Madras coast.

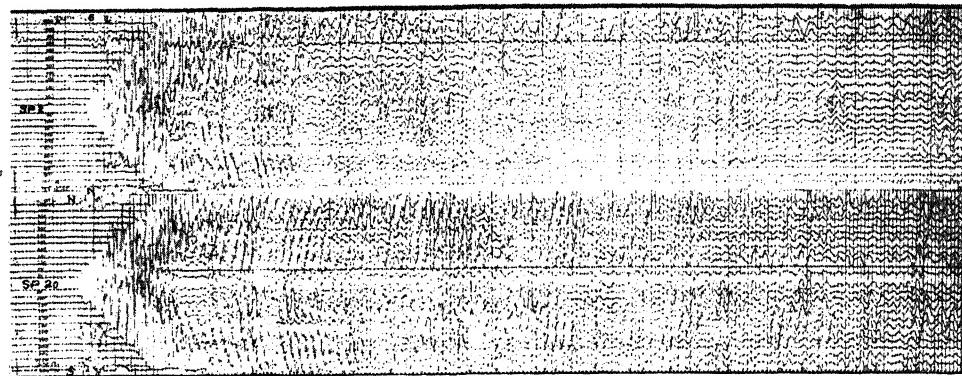


FIG. 3

The other prominent anomaly in the Mannar-gudi-Pattukkottai area trending in a north-south direction as indicated in the Bouguer gravity map is also worthy of further investigation by seismic shooting.

Thanks are due to R. Aravamudhan, P. C. Das, B. Subrahmanyam and others, who assisted the author in the seismic surveys and to Y. R. Bhanumurthy, B. G. K. Murthy, A. K. Menon and others, who carried out the gravity and magnetic observations and the reduction of the field data.

1. Foote, R. B., "On the geological features of the Northern part of Madura District, Pudukkottai State and the Southern Part of Tanjore and Trichinopoly Districts," *Rec. Geol. Surv. India*, 1890, 12, 141 (149-54).
2. Rao, L. Rama, "On the occurrence of an Eocene bed in the Pondicherry Cretaceous area," *Curr. Sci.*, 1939, 8, 166.
3. Vredenburg, E. W., "Considerations regarding the age of the Cuddalore series," *Rec. Geol. Surv. India*, 1908, p. 321.
4. Kailasam, L. N., "Geophysical exploration in the coastal sedimentary belt of Madras State," *Curr. Sci.*, 1958, 27, 476.

A LARGE RED-SHIFT

ASTRONOMICAL data concerned with more distant galaxies are of greater significance to cosmological theories than those relating to our own galaxy and its neighbourhood, although the latter are necessarily much more accurate and detailed. The new science of Radioastronomy enables one to probe to greater depths in space, and the strongest radio sources have been identified with distant galaxies. This provides a promising way of locating such galaxies that show strong emission lines in their spectra. Emission lines permit very large redshifts to be measured.

The recessional velocities of distant nebulae, which are proportional to their distances, are determined by measurement of the Doppler-shift of the absorption lines in their spectra. However, the absorption features of faint nebulae are veiled by the night-sky spectrum and Doppler-shift measurements of extragalactic nebulae of apparent magnitude fainter than 19

are not ordinarily possible. Emission lines, however, remain visible for much fainter galaxies than absorption lines and can be used for their red-shift measurements.

Among the known radio sources discovered by radio-astronomy one has now been identified with a galaxy of apparent magnitude 21, which appears to be the brightest member of a cluster of galaxies. This shows a strong emission line at λ 5448 Å. The emission line is almost certainly the forbidden doublet of ionized oxygen, the laboratory wavelength of which is 3728 Å. Thus the large red-shift $\delta\lambda/\lambda$, corresponds to a velocity of 140000 km./sec. or 0.46 times the velocity of light (R. Minkowski, *Astrophys. J.*, 1960, 132, 909). Baum using photoelectric photometry has found two fainter galaxies with Doppler-shift 0.44. Thus there is reason to believe that all the three galaxies are members of the same cluster.—(*Nature*, 1961, 189, 713).

SUPERPOSABLE PICTURES OF CHROMOSOME STRUCTURE OF *ALLIUM CEPA* IN FEULGEN AND HAEMATOXYLIN SQUASHES

M. K. SUBRAMANIAM AND S. SUBRAMANYAM

Cytogenetics Laboratory, Department of Biochemistry, Indian Institute of Science, Bangalore-12

INTRODUCTION

THE haematoxylin squash method¹⁻³ gave elegant staining of the chromosomes and non-fading permanent preparations. The hydrolysis in N HCl at 60° C. for 10-12 min. prior to staining was reminiscent of a similar step in Feulgen procedure.⁴ Cells stained with leuco-basic fuchsin gradually fade on keeping. If pictures obtained with haematoxylin are superposable on those of Feulgen it would be a permanent record of the observations.

While haematoxylin stains both acidic and basic structures, the Schiff's reagent colours only structures containing DNA. Sections of fixed material hydrolysed as for Feulgen but stained with haematoxylin show both the chromatin and nucleoli in slightly differing shades while a counterstain is necessary to reveal the nucleoli in Feulgen preparations. If it is the fixative which renders the nucleoli stainable with haematoxylin even after hydrolysis, then, avoidance of conventional fixatives should enable obtaining haematoxylin preparations where the nucleoli would remain unstained and the details of chromosome structure and configuration superposable on those stained by the Feulgen technique.

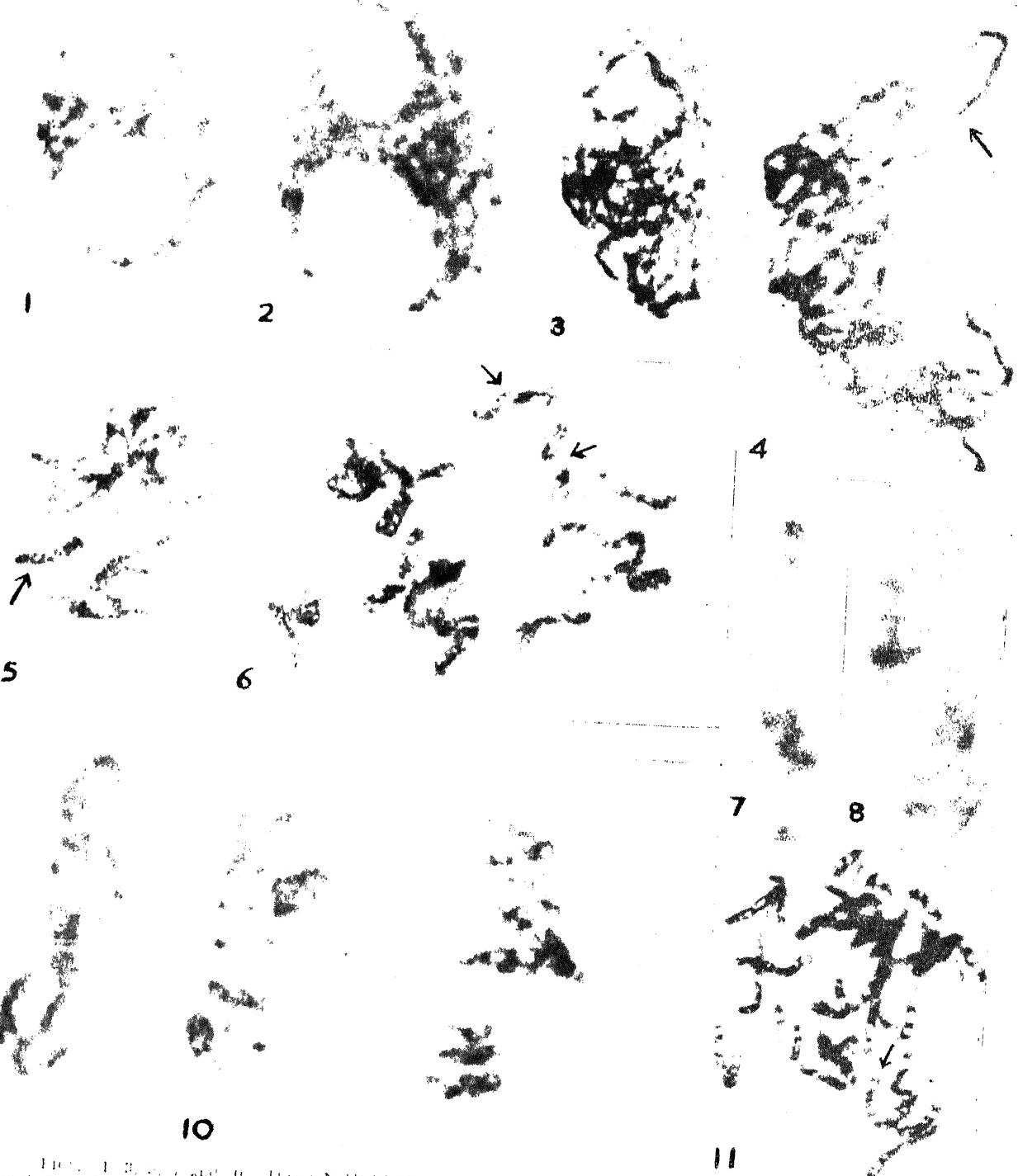
The most obvious procedure is to employ N HCl at 60° C. as the medium for fixation as well as hydrolysis.⁵ Fresh roots of *Allium cepa* exposed for 8 min. to hot HCl were washed in distilled water and stained either with leuco basic fuchsin or with Heidenhain's haematoxylin. For Feulgen staining, the washed roots were transferred to leuco-basic fuchsin and kept in the dark for 3 hrs. After a wash in three changes of SO₂ water for a total duration of 30 min. they were rinsed in distilled water and squashed in 45% acetic acid under a coverslip. The slides and coverslips used should be coated with a thin layer of Mayer's albumen and then flamed. When the spreading of the cells appeared satisfactory, the coverslips were released in 40% alcohol. They were dehydrated in ascending grades of alcohol, then cleared in xylol and mounted in Canada balsam. Some of the material was counterstained with aqueous light-green. The procedure for making haematoxylin squashes was essentially the same as described previously.¹

Since there is a slight increase in the intensity of the stain when made permanent, the cells in the squash should be destained to a stage lighter than actually desired. This could be achieved by the control of the time of stay of the stained material in 45% acetic acid before squashing. The preparations could be made permanent by dehydration with either ethyl or tertiary butyl alcohol. When the latter is used, they could be mounted direct in Canada balsam dissolved in butyl alcohol. The use of ethyl alcohol necessitates clearing in xylol before mounting in Canada balsam.

OBSERVATIONS

The resting nucleus has a reticulated appearance in Feulgen (Fig. 1) as well as haematoxylin (Fig. 2) preparations and the areas occupied by the nucleoli appear unstained. The structural details of the chromosomes during the various phases of the division cycle are also superposable (Feulgen—Figs. 3, 5, 7 and 10; haematoxylin—Figs. 4, 6, 8, 9 and 11). During prophase, the chromosomes appear to consist of two chromatids and the free ends of one such pair are indicated by an arrow in Fig. 4. The general impression one gets is that the chromatids are relationally coiled.

The most unexpected discovery was that while the two chromatids of the metaphase chromosome showed relational coiling (Figs. 6, 8 and 9), each chromatid itself appeared linearly vacuolated reminiscent of descriptions of coiling of a pair of chromonemata.^{6,7} In other words, the appearances are suggestive of a quadri-partite structure of the metaphase chromosome.⁸ It need hardly be mentioned that haematoxylin pictures were superior to those of Feulgen in their clarity for demonstration of the relational coiling of the chromatids as well as the coiled pair of chromonemata. This is exemplified by enlargements of individual chromosomes (Figs. 7, 8 and 9) indicated by arrows in Figs. 5 and 6. At anaphase the daughter chromosomes show the same type of configuration as exhibited by the individual chromatids at metaphase. The free ends of the two chromonemata of an anaphase chromosome are indicated by an arrow in Fig. 11. The coiling of the chromonemata at meta- and anaphases appears to be of the caduceus type.⁹



FIGS. 1, 2, 5, 6, 7, 8, 9 and 11. Direct N HCl Iron Hematoxylin squash. Fig. 1. Resting nucleus, $\times \text{ca. } 2,500$. Fig. 3. Prophase. The nucleosome shows the quadri-partite structure, $\times \text{ca. } 6,000$. Fig. 6. Metaphase. One chromosome shows the quadri-partite structure, $\times \text{ca. } 6,000$. Fig. 10. Anaphase. Most chromosomes consist of a pair of causally coiled chromonemata, $\times \text{ca. } 2,900$.

FIGS. 2, 4, 8, 9 and 11. Direct N HCl Iron Hematoxylin Squash. Fig. 2. Resting nucleus, $\times 2,500$. Fig. 6. Metaphase. Compare with Fig. 3. Arrow indicates the bifid end of a chromosome, $\times \text{ca. } 1,500$. Fig. 6. Metaphase. The elation shows relational coiling. Each chromatid is composed of a pair of chromonemata, $\times \text{ca. } 1,500$. Fig. 8 and 9. Enlargements of two of the chromosome indicated by arrows in Fig. 6. Note the relational coiling and quadri-partite structure, $\times \text{ca. } 6,000$. Fig. 11. Anaphase. The free ends of one pair of chromonemata, $\times \text{ca. } 1,500$.

DISCUSSION

Squash techniques obviate the use of conventional fixatives so necessary to render a root suitable for serial sectioning. It is this advantage which enabled devising a procedure by which the details shown by haematoxylin would only be those that are seen after Feulgen. Unexpectedly, the new method revealed also the structural details of the chromosomes during the various phases of mitosis. This was not very surprising since one of the methods used for revealing the spiral structure is exposure to fumes of concentrated HCl.^{7,8,10,11} But exposure to acid fumes was only a pretreatment which was followed by preservation in various fixatives. Accurate control of the pretreatment is rather difficult. A clear evaluation of the action of fixatives after such pretreatment is not also easy. These limitations are minimised in the new technique devised. The temperature and time of hydrolysis in N HCl of fresh roots could be controlled and there is no subsequent fixation. The results obtained are, therefore, easily reproducible.

Though the first description of the chromosome spiral by Baranetzky in 1880 was from damaged living cells, a wide variety of agencies have been used to improve its clarity for purposes of analysis.¹¹ Naturally, the spiral thus demonstrated is a vital artefact. The figures presented show that the same details of chromosome structure are seen in haematoxylin

and Feulgen preparations. But then, the agency producing the clarity of structural details is not the stains but the use of N HCl at 60° C. as the medium for fixation and hydrolysis.

The chromosome matrix appears Feulgen negative, the chromonemata alone being Feulgen positive. The clarity of pictures in which the free ends of the chromonemata lie separated (Fig. 11) suggests that the pairs of chromonemata are enclosed within a pellicle.¹² Other methods of approach are now being explored to evaluate whether the configuration of the coiling of the chromonemata is similar after pretreatment with different agencies and whether clear proof would be available for the presence of a pellicle.

1. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.
2. Meenakshi, G. and Subramaniam, M. K., *Ibid.*, 1960, **29**, 438.
3. Royan, S., *Ibid.*, 1961, **30**, 143.
4. Lesser, M. A., *Internat. Rev. Cytol.*, 1953, **2**, 231.
5. Gerstel, D. U., *Stain Technol.*, 1949, **24**, 95.
6. Koshy, T. K., *Jour. Roy. Microsc. Soc.*, 1933, **53**, 299.
7. Mensinkai, S. W., *Ibid.*, 1939, **59**, 82.
8. Kaufmann, B. P., *Bot. Rev.*, 1948, **14**, 57.
9. — and De, D. N., *Jour. Biophys. and Biochem. Cytol.*, 1956, **2**, 419.
10. La Cour, L., *Stain Technol.*, 1935, **10**, 57.
11. Manton, I., *Biol. Revs.*, 1950, **25**, 486.
12. Swanson, C. P., *Cytology and Cytogenetics*, MacMillan and Co., London, 1958.

INDIA'S POPULATION ACCORDING TO 1961 CENSUS

PRELIMINARY figures of the population of India according to the census of February-March 1961 were published recently. (The figures for Manipur, Nagaland, and North-East Frontier Agency are not included.) The total population is 436,424,429, out of which 224,957,948 are males and 211,466,481 are females. The increase in population over the figures for 1951 is 77,207,524. This means that during the decade 1951-61 the population has increased by 21.49%. This growth is 61% faster than the rate at which the population grew between 1941-51 which was 13.34%. Out of the 436 millions, the rural population is 358 millions or 82% and the urban population is 78 millions or 18%.

Indian Union has an area of 1,127,345 sq. miles. The density of population is 384 per square mile as against 316 in 1951. Regarding sex-ratio, the number of females per 1,000 males is 940, as against 946 in 1951.

The distribution of population amongst the

15 States of the Union, and the percentage increase during the decade 1951-61 are shown in the following table.

TABLE I

States	Area (in sq. miles)	Population 1000 (in millions)	Percentage increase (in millions) over 1951 figure
Andhra Pradesh	..	106.0	35.98
Assam	..	47.1	11.86
Bihar	..	67.2	46.46
Gujarat	..	72.1	20.62
Jammu and Kashmir	..	—	3.58
Kerala	..	15.0	16.88
Madhya Pradesh	..	171.2	32.39
Madras	..	50.1	33.65
Maharashtra	..	118.9	39.50
Mysore	..	74.1	23.55
Orissa	..	60.2	17.57
Punjab	..	47.1	20.30
Rajasthan	..	132.2	20.15
Uttar Pradesh	..	113.5	73.75
West Bengal	..	39.9	39.97

LETTERS TO THE EDITOR

APPLICATION OF THEORY OF IRREVERSIBLE POLAROGRAPHIC WAVES TO THE REDUCTION OF BRILLIANT GREEN AT THE DROPPING MERCURY ELECTRODE

In recent years various theories¹⁻⁵ have been developed for elucidation of polarographic irreversible reduction processes which are not governed by the familiar Heyrovsky-Ikkovic equation.^{6,7} Of these, the mechanism put forward by Delahay^{6,8} assumes that the electrode process is controlled by (a) rate of diffusion and (b) rate of chemical reaction preceding or following the electrode process.⁸ The present article reports the applicability of Delahay's theory to the reduction of brilliant green (B.G.), viz., 44' bisdiethyl amino-triphenyl methyl chloride at the dropping mercury electrode (dme).

Brilliant green of medicinal quality was purified by the partition methods of Lewis, Magel and Lipkin.⁹ Potassium nitrate used as a supporting electrolyte was B.D.H. 'Analar' sample. Polarographic measurements were carried out with a manual polarograph described elsewhere¹⁰; the capillary employed had the characteristics: $m = 1.462$ mg. sec.⁻¹; $t = 2.564$ sec. All polarograms were taken in deoxygenated solutions. Methyl cellulose solution (0.02%) was used as maximum suppressor.

Preliminary experiments showed that the polarograms of B.G. in aqueous solutions were highly distorted in accord with the data of earlier workers.¹¹ Use of 50% alcohol-water mixture resulted in the production of well-defined stable polarograms. Figure 1 gives a typical polarogram indicating two-step reduction of B.G. at dme, with $(E_1)_1 = 0.37$ and $(E_1)_2 = 0.77$ volt *vs.* SCE. Computation of the number (*n*) of electrons involved in the

reduction process, from $\log \frac{i}{i_i} \text{ vs. } E$ plots

was not possible. It could however be determined from Ikkovic's equation,¹² which required the use of the data on the diffusion coefficient *D* of B.G.; *D* was determined in separate experiments using McBain and Dawson¹³ cell. *D* for B.G. corresponded to 1.142×10^{-6} cm.² sec.⁻¹ under polarographic conditions. These data gave *n* = 1 for both the reduction waves (Fig. 1).

Employing the value of *n* and *D* the values of the rate constant *k* of the irreversible process were evaluated⁵ from the data in Fig. 1.

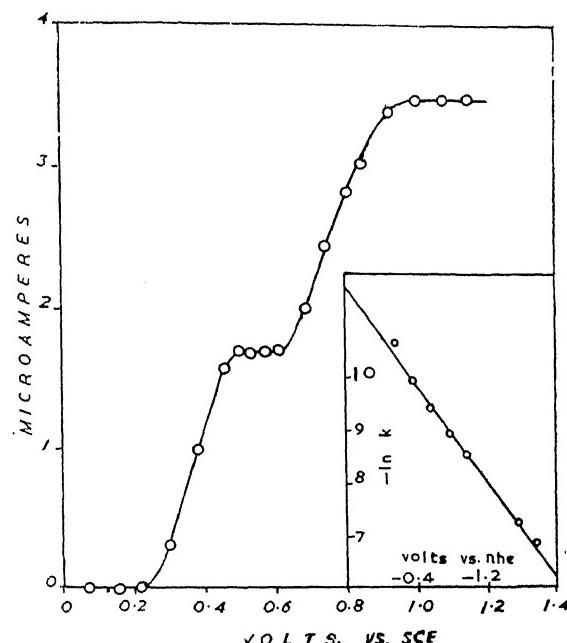


Fig. 1. Irreversible polarographic reduction of brilliant green.

These results are given in Table I. It is of interest to note that *k* is 2.67×10^{-5} cm. sec.⁻¹ at $E = -0.018$ volts *vs.* N.H.E. at 25° C., which indicates the slow nature of the electrode reaction leading to the irreversible nature of the reduction process. Data in Table I show that *k* is markedly dependent on applied potential *E*. The variation of *k* with *E* is governed by the equation

$$\ln k = \ln k_0 - \frac{n \alpha F E}{R T} \quad (1)$$

In accord with Equation 1 $\ln k$ is linearly variant with *E* (see inset Fig. 1) suggesting the applicability of Delahay's theory to the irreversible reduction of B.G. at dme. The slope of the plot, $\ln k$ *vs.* *E*, gives a value of 0.59 for α , which is defined as the fraction of the potential favouring the cathodic reaction. Further, the data gave a value 1.92×10^{-5} cm. sec.⁻¹ for *k*₀ for the rate constant at *E* = 0.

TABLE I
Determination of the rate constant of irreversible reduction of brilliant green
Concentration of B.G. = 1.70 mM
Concentration of KNO_3 = 0.1 M

Applied potential Volt vs. N.H.E.	Current μA	$\beta k D^{-\frac{1}{2}} \times 10^2$	$k \times 10^5$
-0.018	0.085	1.58	2.67
-0.038	0.160	2.94	4.69
-0.058	0.260	4.76	8.55
-0.078	0.425	7.72	14.10
-0.098	0.600	10.80	20.31
-0.118	0.775	14.40	28.21
-0.158	1.125	20.44	74.80

Thanks are due to Prof. S. N. Gundu Rao, Director, for his kind interest in the work and to the Scientific Research Committee U.P., for a maintenance grant to one of us (S. S. K.).

Dept. of Physical Chemistry
National Sugar Inst.,
Kanpur, January 11, 1961.

N. A. RAMAIAH.
SARVAGYA S. KATIYAR.

1. Brdicka, R. and Wiesner, K., *Coll. Czech. Chem. Commun.*, 1947, **12**, 138.
2. Koutecky, J. and Brdicka, R., *Ibid.*, 1947, **12**, 337.
3. Tamamushi, R. and Tanaka, N., *Bull. Chem. Soc. Japan*, 1949, **22**, 227; 1950, **23**, 110; 1949, **22**, 187.
4. Delahay, P., *J. Amer. Chem. Soc.*, 1951, **73**, 4944.
5. — and Strassner, J. E., *Ibid.*, 1951, **73**, 5220.
6. Heyrovsky, J. and Ilkovic, D., *Coll. Czech. Chem. Commun.*, 1935, **7**, 198.
7. Kolthoff, I. M. and Lingane, J. J., *Polarography*, Interscience Publishers Inc., 1946, p 144.
8. Ramaiah, N. A. and Chaturvedi, R. K., *Second Intern. Polaro. Cong.*, 1959, p. 766.
9. Lewis, G. N., Magel, T. T. and Lipkin, D., *J. Amer. Chem. Soc.*, 1942, **64**, 1774.
10. Ramaiah, N. A. and Vishnu, *Proc. Ind. Acad. Sci.*, 1956, **43 A**, 297.
11. Kaye, R. C. and Stonehill, H. I., *J. Chem. Soc.*, 1952, p. 3231.
12. Ilkovic, D., *Coll. Czech. Chem. Commun.*, 1934, **6**, 498.
13. McBain, J. W. and Dawson, C. R., *Proc. Roy. Soc.*, 1935, **152A**, 32.

OXIDATION OF THIOCYANATE WITH CHLORAMINE-T

THE sulphur in potassium thiocyanate is known to get oxidised to sulphuric acid by several oxidising agents such as bromine,¹ hypohalite,² iodine,³ iodate⁴ and hydrogen peroxide.⁵ Recently the kinetics of the oxidation of thiocyanate by hydrogen peroxide has been studied and it is reported that the reaction is independent of the pH of the medium.⁵ Chloramine-T has been observed to bring about rupture between S-S, N-S⁶ and C-S⁷ linkages and oxidise

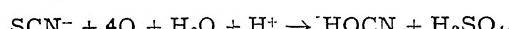
all the sulphur to sulphuric acid in an acid medium. It was of interest to study the oxidation reaction between thiocyanate and chloramine-T and the results of such an investigation are reported in the present communication.

The following solutions were prepared with chemicals of high grade purity and their strength estimated by standard methods.

(1) Decinormal chloramine-T⁸; (2) Decinormal potassium thiocyanate⁹; (3) Decinormal sodium arsenite; (4) Decinormal sodium thiosulphate; (5) Standard buffers of pH lying between 2 and 13.¹⁰

Procedure.—A known excess of chloramine-T solution (10 ml.) was mixed with 10 ml. of hydrochloric acid (1 N) or any of the buffer to which a known amount of potassium thiocyanate was added (0.5 ml. to 2 ml.). The reaction mixture was shaken occasionally and allowed to stand for about half an hour. The excess of chloramine-T was then estimated by the addition of 10 ml. of potassium iodide solution (10%), and titrating the iodine liberated against thiosulphate solution. In the alkaline medium the excess of oxidising agent was treated with a known excess of sodium arsenite solution and the excess of arsenite was estimated by titrating with a standard iodine solution after acidifying and removing the excess acid by an excess of sodium bicarbonate solution. From the titre values it was possible to calculate the number of equivalents of oxidant consumed by a mole of thiocyanate. The results of a few representative experiments are presented in Table I.

It can be seen from the results of the table that in an acid medium, every mole of thiocyanate consumes eight equivalents of chloramine-T whereby all the sulphur is converted to sulphate in terms of the equation



At and above pH 7, the oxidation is not complete and it becomes extremely sluggish. Only a part of the thiocyanate seems to get oxidised between pH 8 and 13. At pH 13, there is practically no oxidation of the thiocyanate even if the reaction is allowed to take place for over 24 hours. Even after warming at 40° C. for one hour very little oxidant was consumed by the thiocyanate. However warming the reaction mixture at 40° C. for one hour at pH 7 resulted in the quantitative oxidation of the thiocyanate (Expt. No. II).

It is clear from the above results that C-S linkage in thiocyanate can be broken and all the sulphur is oxidised to sulphuric acid

TABLE I
Oxidation of thiocyanate by chloramine-T

Expt. No.	pH of the medium	No. of moles of KCNS taken for the expt.	No. of equivalents of oxidant consumed per mole of thiocyanate $\times 10^{-3}$	No. of equivalents consumed per mole of thiocyanate $\times 10^{-3}$
1	less than 0.1	5.48	43.91	8.01
2	-	10.96	88.51	8.07
3	-	16.44	131.20	7.98
4	-	21.92	174.00	7.94
5	2	5.48	43.91	8.01
6	3	5.48	43.91	8.01
7	4	5.48	43.91	8.01
8	5	5.48	43.91	8.01
9	6	5.48	43.91	8.01
10	7	5.48	34.65	6.32
11	7	5.48	43.91	8.01
			(After warming)	
12	8	5.48	23.64	4.31
13	9	5.48	28.46	5.19
14	10	5.48	30.63	5.37
15	13	5.48	7.11	1.29
16	1 N	5.48	9.60	1.76
		NaOH (10 ml.)		

quantitatively. The method could be employed to estimate thiocyanate in an acid medium.

The authors wish to express their grateful thanks to Professor M. R. A. Rao for his keen interest in the work.

Dept. of Inorganic V. R. SATYANARAYANA RAO
and Phy. Chem., A. R. VASUDEVAS MURTHY
Indian Inst. of Science,
Bangalore 12, February 14, 1961

1. Treadwell, F. P. and Mayr, C. J. *Amer. Chem.*, 1915, **92**, 127.
2. Tomoneda, O. and Leek, M. *Collection Czech. Chem. Commun.*, 1938, **10**, 353.
... and Filipova, P. *Abstr.*, 340, 41a.
3. Rupp, E. and Schied, *Ber.*, 1902, **35**, 2191; *Arch. Pharm.*, 1907, **243**, 460.
4. Hammock, L. W., Beeson, D. and Swift, E. H., *Anal. Chem.*, 1940, **21**, 970.
5. Wilson, L. R. and Harris, G. M., *Jour. Am. Chem. Soc.*, 1900, **22**, 4615.
6. Sharada, K. and Vasudeva Murthy, A. R., *J. Chem. Res.*, 1960, **93**, 1251.
7. Satyanarayana Rao, V. R. and Vasudeva Murthy, A. R., *Talanta*, 1960, **4**, 206.
8. Vasudeva Murthy, A. R. and Sanjiva Rao, B., *Proc. Ind. Acad. Sci.*, 1962, **35A**, 7.
Bishop, E. and Jennings, V. J., *Talanta*, 1958, **1**, 197.
9. Kolthoff, I. M. and Sandell, E. B., *Text Book of Quantitative Inorganic Analysis*, 3rd Edition, Macmillan Company, New York, 1952, 542, 592, 593.
10. Britton, H. T. S., *Hydrogen Ions*, Chapman and Hall, Ltd., London, 1955, **1**, 352.

INCREASED FIBRE CONTENT IN HEMP (*CANNABIS SATIVA*) AND SUNN (*CROTALARIA JUNCEA*) BY APPLICATION OF GIBBERELLINS

STEM elongation in plants is the most characteristic response to gibberellin application and this was, until recently,¹ believed to be the result of cell elongation. More recently it has been shown that gibberellin causes both increase in length and in number of cells^{2,3} in the epidermis, cortex and pith. The effect of gibberellin on the hemp and sunn plants studied here has shown that gibberellin enhances the height and diameter of the stem as well as number, length and thickness of lignified fibres.

Ten hemp plants with 2-3 internodes were sprayed with a 100 p.p.m. aqueous solution of gibberellin on three successive days initially and then sprayed at weekly intervals for six weeks, when the treated and control were compared with respect to their fibre characteristics. The results are recorded in Table I.

In case of 'sunn' two plots of about 80 plants each were grown. To one of these, application of gibberellin was made when 2-3 week old and subsequently at weekly intervals for about 2 months. One month after the last application, the plants of the treated plot as well as the control were harvested. The height and basal diameter of all the plants were recorded. The individual fibres were isolated by maceration and their lengths measured. The diameter of the fibres was determined from the transverse section of the stem using a micrometer. Equal number of treated and untreated plants were subjected to retting process and the yield of fibre per plant was calculated from the data so obtained. The results are recorded in Table I.

In another set of experiment sunn seeds were sown in two plots of 4' x 12' each. The plants in one of these plots were divided into 4 groups of about 20 plants each. Gibberellin (Pfizer) was applied in the form of a foliar spray of 100 ppm. aqueous solution containing ½% gum acacia as a surface active agent. To the first group the application of gibberellin was made one week after sowing, to the second group 2 weeks after sowing, to the third group 3 weeks after sowing while the fourth group as well as the plants in the second plot were kept as controls. These applications were continued at weekly intervals, for a period of eight weeks. The height of the plants was recorded at the time of each application and is shown in Fig. 1.

The third group to which application was made three weeks after sowing the seeds showed maxi-

TABLE I
Quantitative effect of Gibberellin on the fibres of *Crotalaria juncea* and *Cannabis sativa*

Character	Treated				Untreated				S.D.	't'	d.f.	1% of t value
	Number of readings	Mean	Variance	S.D.	Number of readings	Mean	Variance	S.D.				
<i>Crotalaria juncea</i>												
Length of fibres in cm.	25	1.04	0.0316	0.1778	21	0.452	0.005	0.0707	14	44	less than 2.75	
Diameter of fibres in μ	24	39.5	54.1	7.3553	25	24.7	23.4	5.4222	7.8	47	"	
Length of stem in cm.	50	258.6	454.7	21.324	66	223.4	483	21.977	8.54	114	"	
Basal diameter of stem in mm.	41	1.2	0.144	0.3795	62	0.68	0.1013	0.3183	7.4	101	"	
Yield of fibre per plant in g.	..	2.83	..	..	1.93	..	..	..	..	..	..
<i>Cannabis sativa</i>												
Fibre diameter	..	16	24	8.44	16	18	6.25	2.5	6.06	30	less than 2.75	
Fibre wall thickness	..	15	7.6	0.82	15	4.7	0.600	0.774	9.2	28	"	
Fibre length in cm.	..	18	3.8	0.200	20	0.43	0.04	0.2	29	36	"	
Bark/wood ratio fresh	..	0.37	..	..	..	0.33	..	..	..	..	..
Bark/wood ratio dry	..	0.53	..	..	..	0.51	..	..	..	..	..

mum, the second group less and first group the least gain in height showing thereby that the best effects are produced when gibberellin application is started on plants which are 3 weeks

The gibberellin treated hemp plants recorded increase in the average length, diameter and wall thickness of the individual fibres and an increased number of fibres over control plants. The treated plants showed a higher bark/wood ratio which is a desirable criterion⁶ in fibre-yielding plants. Treated hemp plants showed a complete lack of lateral branching which also is a desirable feature.⁷ The data given in Table I reveals that gibberellin application causes a definite increase in the stem height and diameter, fibre length and diameter and overall yield of fibres in case of sunn plants. The differences in the mean values for the different characteristics for the treated and untreated plants, as tested by means of the "t"-test, show that all the t values are very highly significant, being much larger than the 1% values. This confirms the hypothesis regarding the effect of gibberellin. The gibberellin induced increase of fibres in sunn is not as outstanding as in the case of hemp. However, the results obtained suggest that gibberellin may offer commercial possibilities in the natural fibre industry.

We are grateful to Dr. D. D. Joshi of the Statistics Department, Punjab University, for the statistical evaluation of our data.

Pharmacognosy Section, C. K. ATAL.
Department of Pharmacy, J. K. SETHI.
Panjab University, Chandigarh-3,
March 10, 1960.

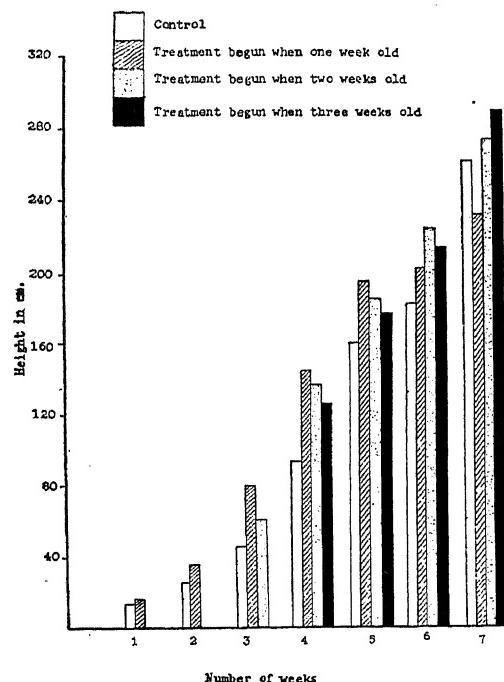


FIG. 1

old, while the plants on which gibberellin application was started when one week old, there was an inhibitory effect on the height as compared to the controls.

1. Stowe, B and Yamaki, T., *Ann. Rev. Pl. Physiol.*, 1957, 8, 181.
2. Greulach, V. and Haesloop, J., *Amer. J. Bot.*, 1958, 45, 566.

3. Sachs, R. M. and Lang, A., *Science*, 1957, **125**, 1144.
4. Guttridge, C. G. and Thompson, P. A., *Nature, Lond.*, 1958, **183**, 197.
5. Feucht, J. R. and Watson, D. P., *Amer. J. Bot.*, 1958, **45**, 520.
6. Kundu, B. C. and Kar, B. K., *Proc. 1st Indian Sci. Congr.*, 1954, **3**.
7. Kar, B. K., "Presidential Address," *46th Indian Sci. Congr., Delhi*, 1959, 1.

SOME 2-STYRYL DERIVATIVES OF 4 (3)-QUINAZOLONES AS POTENTIAL ANTIMALARIALS AND AMOEVICIDES

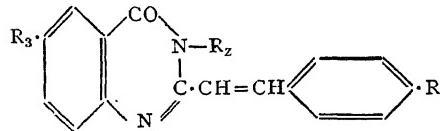
EARLIER in this series, synthesis of variously substituted 2-alkyl-3-aryl (or substituted sulphonamido-phenyl)-6-halo (or alkyl)-4(3)-quinazolones have been reported as potential antimalarials.^{1,2} A few 2-methyl-3-aryl-4(3)-quinazolones have also been reported to be active against *P. gallinaceum* in chicks.³⁻⁵ However, not much work seems to have been done regarding the potentiality of 2-styryl-4(3)-quinazolone derivatives as antimalarials. Recently some 3-substituted-8-hydroxy (or methoxy)-4(3)-quinazolones,⁶ and 3-alkyl-2-styryl-8-hydroxy (or methoxy)-4(3)-quinazolones⁷ have been reported as potential amoebicides.

It was thus considered worthwhile to synthesise 2-styryl-3-aryl-6-halo (or alkyl)-4(3)-

quinazolone derivatives and study their antimalarial and amoebicidal properties (Table I).

Most of the desired 2-methyl-3-aryl-6-halo (or alkyl)-4(3)-quinazolones have been synthesized according to the general methods of Bami and Dhatt¹ and other workers.^{5,8} Normally, 2-styryl-3-aryl-6-halo (or alkyl)-4(3)-quinazolones were obtained in good yield by refluxing for 7-8 hours different 2-methyl-3-aryl-6-halo (or alkyl)-4(3)-quinazolones with an excess of benzaldehyde or para-anisaldehyde without employing any condensing medium. Whereas in case of condensations of 2-methyl-3-aryl-6-halo (or alkyl)-4(3)-quinazolones with p-dimethyl-amino-benzaldehyde, only equivalent quantities were heated at 180-90° C. for 7-8 hours. These compounds (Table I) got separated on diluting the reaction mixture with ethanol, followed by cooling in an ice-bath. They were crystallised from ethanol-benzene mixture as pale to lemon-yellow granules or needles. Antimalarial activity of these compounds against *P. gallinaceum* in chicks was tested according to the method of Jaswant Singh *et al.*^{10,11} These compounds were found to be inactive at 4 times the quinine equivalent dose (Table I). However, some of these compounds showed promising results when tested *in vitro* for their amoebicidal activity against E.A. strain of *Entamoeba histolytica*¹² (Table I). Further work is in progress.

TABLE I
2-p-substituted styryl-3-aryl-6-alkyl (or halo)-4 (3)-quinazolones



S. No.	MIS	R ₁	R ₂	R ₃	M.P. °C. Un-corrected	Molecular formula	Analysis-N% Required Found	Anti-malaria activity at 4Q	In vitro minimal amoebicidal concentration (μg./ml.)
1	447	H	p-bromophenyl	H	219	C ₂₂ H ₁₅ BrN ₂ O	6.95 7.03	6.89 7.41	Nil Nil
2	467	OCH ₃	p-phenetyl	H	181	C ₂₅ H ₂₂ N ₃ O ₃	7.03 11.02	7.41 11.25	Nil Nil
3	406	N(CH ₃) ₂	m-tolyl	H	190	C ₂₅ H ₂₃ N ₂ O	7.33 6.80	7.70 7.10	100->100 Nil
4	456	H	p-phenetyl	CH ₃	205	C ₂₅ H ₂₂ N ₂ O ₂	7.33 9.13	7.70 9.28	Nil Nil
5	461	OCH ₃	p-phenetyl	CH ₃	191	C ₂₆ H ₂₄ N ₂ O ₃	6.80 9.13	7.10 9.28	100 Nil
6	449	N(CH ₃) ₂	p-bromophenyl	CH ₃	258	C ₂₅ H ₂₂ BrN ₂ O	7.81 7.81	>100 7.6	>100 Nil
7	431	H	Phenyl	Cl	236	C ₂₂ H ₁₅ ClN ₂ O	7.81 6.69	7.6 7.02	100 Nil
8	443	OCH ₃	p-anisyl	Cl	210	C ₂₄ H ₁₉ ClN ₂ O ₃	6.69 9.63	7.02 9.43	100 Nil
9	451	N(CH ₃) ₂	o-chloro-phenyl	Cl	237	C ₂₄ H ₁₉ Cl ₂ N ₂ O	6.47 6.47	>100 6.87	>100 Nil
10	420	H	p-anisyl	Br	211	C ₂₃ H ₁₇ BrN ₂ O ₂	6.05 6.05	100->100 6.21	100 Nil
11	428	OCH ₃	p-anisyl	Br	235	C ₂₄ H ₁₉ BrN ₂ O ₃	9.13 9.13	100 9.34	100 Nil
12	408	N(CH ₃) ₂	o-tolyl	Br	255	C ₂₅ H ₂₂ BrN ₂ O	10(?) [*] -100 10(?) [*] -100		

* There were some indications of amoebicidal action at 10 μg./ml. But, however, there was no complete kill of amoeba at this concentration.

Author's thanks are due to the Director, Central Drug Research Institute, Lucknow, for facilities in carrying out tests for amoebicidal activity.

Chemistry Laboratory,
Malaria Institute of India,
Delhi, January 2, 1961.

1. Bami, H. L. and Dhatt, M. S., *J. Sci. and Indust. Res.*, 1957, **16B**, 558.
2. Dhatt, M. S. and Bami, H. L., *Ibid.*, 1959, **18C**, 256.
3. Coatney, G. R., Cooper, W. C., Eddy, N. B. and Greenberg, J., *Public Hlth. Monograph* (U.S. Public Health Service), 1953 No 9, 202.
4. Jain, M. K. and Narang, K. S., *Res. Bull. E. Punjab University*, 1953 **29**, 51.
5. Salimath, R. S., Patel, S. R. and Shah, N. M., *J. Ind. Chem. Soc.*, 1956, **33**, 140.
6. Iyer, R. N., Niya Anand and Dhar, M. L., *J. Sci. and Indust. Res.*, 1956, **15C**, 1.
7. — and Dhar, M. L., *Ibid.*, 1958, **17C**, 193.
8. Shakti Rani (Miss), Vig, O. P., Gupta, I. S. and Narang, K. S., *J. Ind. Chem. Soc.*, 1953, **30**, 331.
9. Bogert, M. T. and Beal, G. D., *J. Amer. Chem. Soc.*, 1912, **34**, 516.
10. Jaswant Singh, et al., *Indian J. Malar.*, 1952, **6**, 145.
11. — et al., *Ibid.*, 1953, **7**, 117.
12. Kaushiva, B. S. (Unpublished work).

CRYPTOCOCCUS NEOFORMANS FROM PATIENTS IN POONA

THERE have been only very few reports of the occurrence of cryptococcosis in India, chiefly due to lack of diagnosis based on cultural studies. Sinha and Barua¹ reported cryptococcal meningitis in India and many of the suspected cases have remained unrecorded due to lack of isolation of causal organism. An account of two cases of cryptococcosis from Sassoon Hospitals, Poona, is presented in this note.

Studies were made in two patients admitted to the hospital with low grade fever, and cough. One of them was treated with chloromycetin resulting in the lowering of body temperature to normal, but with the continuation of cough and expectoration. Repeated examination for acid fast bacteria was negative, but fluoroscopy revealed bronchovascular markings and emphysema. Microscopic examination and cultural study of the bronchoscopic aspirations revealed the presence of *Cryptococcus neoformans*. (Sanf.) Vuill.

The second case was a child, 6 years old (male) with severe pain in head and neck, and suspected for tubercular meningitis. Intermittent fever, severe cough and slight loss of vision were other symptoms noticed. Microscopic examination of the bronchoscopic aspirations,

stained with India ink, showed *Cryptococcus neoformans*, with characteristic mucinous capsule 3–6 μ in diameter. Centrifuged cerebro-spinal fluid also showed the same organism.

The causal organisms in both cases were cultured on Sabouraud's agar, and comparative morphological and cultural studies were carried out with an authentic culture of *Cryptococcus neoformans*. Animal inoculations were made in 6 weeks' old mice weighing 25–28 gm. They were inoculated intracerebrally with 0.3 ml. of spore suspension. All the 3 mice inoculated with the spore suspension died between 10 and 15 days, while the controls remained alive. A routine cultural study in cases of meningitis (where the blood and cerebro-spinal fluid are negative for bacterial pathogens) may reveal more cases of cryptococcosis in India, which usually escape detection.

Hindustan Antibiotics Res. Centre,
Pimpri (Poona), A. A. PADHYE.
February 3, 1961. M. J. THIRUMALACHAR.

1. Sinha, G. B and Barua, D., *Bull. Calcutta Trop. Schl. Med.*, 1960, **8**, 140.

ROLE OF PLANTS IN THE MOVEMENT OF PHOSPHORUS BY RADIOACTIVE ISOTOPIC STUDIES

IT is generally believed that phosphorus is immobile in soils.^{1,2} If this were so, continuous crop growth without adequate addition of phosphatic fertilizers should deplete the content of phosphorus in surface soils irrespective of its distribution in subsoils. However, it was observed³ that continuous growth of legumes showed a tendency to increase the surface soil phosphorus. This has shown the possibility of tapping the subsoil phosphorus through suitable crop rotations and reduce the fertilizer need as regards phosphorus. In order to find out whether the leguminous plants can transfer nutrients from one zone to the other, the following experiment was devised.

Seedlings of ladino clover were raised in a medium of vermiculite moistened with the complete nutrient solution of the following composition with respect to major elements; Ca-78 ppm.; Mg-42 ppm.; NH₄-54 ppm.; K-233 ppm.; SO-170 ppm. and P-62 ppm. This was supplemented with the necessary minor elements. When the seedlings were one-month old the plants were carefully removed from the medium with the roots intact and washed with distilled water. The root systems of four plants were equally divided into two portions 'A' and 'B' equal also in respect of each plant. In the

first set, the portion 'A' was dipped in sand moistened with the above complete nutrient solution containing 62 ppm. phosphorus while the other portion 'B' was dipped in a tube containing only distilled water. The nutrient solution in the sand portion could be renewed every alternate day after drawing off the residual solution through an opening at the bottom fitted with a stop-cock. In the second set, plants were kept similarly except that the nutrient solution in 'A' contained no phosphorus as control. In a third set, 30 ml. of tagged P^{32} of 6 μ c specific activity in the form of calcium mono-phosphate, amounting to a total of 60 mg. of phosphorus was added in the 'A' portion after 7 days of the growth under the conditions of the first set. First and second sets were replicated twice. After 15 days, the portions in 'B' were carefully removed, filtered with glass wool and made up to 100 ml. In the case of treatment having P^{32} , an aliquot of 2.5 ml. was dried and the activity count was taken in an end window counter of the tracer lab sealer, under the identical geometrical conditions as that for the original solution. The calculations for the phosphorus transferred were made after deducting for the background. The phosphorus in the remaining sets containing ordinary phosphorus was estimated by the Dickman and Bray's colorimetric procedure.⁴

The results obtained are as follows:—

TABLE I

Amount of phosphorus transferred from one root zone to another

Treatment in the 'A' portion of the root zone	Phosphorus transferred in the distilled water surrounding the root system in 'B'
1 Nutrient solution with P at 62 μ p.m.	15
2 do. do. do. for one week	15
3 with 60 mg. of P^{32} tagged mono calcium phosphate (time of contact of P^{32} solution with roots, 7 days.)	7,305
4 Control nutrient solution with out P	Nil
5 do. do. do.	Nil

The above evidence shows that plants can act as medium of transfer of phosphorus from one part of the rhizosphere to another. While possibility exists that the amount of phosphorus found in zone 'B' in the experiment without radioactive P^{32} could either have been transferred from portion 'A' or from the roots in 'B', there is no ambiguity in the experiment

using radioactive phosphorus because the radioactive phosphorus was included only in the portion 'A' and not either in the roots or solution of portion 'B'.

Thus it appears possible to use suitable plants in rotation as media for transfer of subsoil phosphorus to the surface and thereby reduce the phosphatic fertilizer needs of surface soil.

Thanks are due to Dr. J. Hanway, Associate Professor of Soils, for giving the author necessary facilities for this work at Iowa State College, U.S.A.

Indian Agricultural Res. Inst., B. V. SUBBIAH, New Delhi-12, January 6, 1961.

- Russell, E. J., *Soil Conditions and Plant Growth*, 8th Edition, 1950.
- Bray, R. H., *Diagnostic Techniques for Soils and Crops*, Amer. Potash. Inst., Washington 6, D.C., 1948.
- Subbiah, B. V., et al., *Jour. Ind. Soc. Soil Sci.*, 1956, 4(3), 167.
- Dickman, S. R. and Bray, R. H., *Industrial Engineering Chemistry*, 1940, 32, 665.

ABO BLOOD GROUPS IN THE RAJ GONDS

A PARTY belonging to the Department of Anthropology, Government of India, Calcutta, and under the leadership of Shri S. R. Das, Anthropologist of the aforesaid department, carried out a Genetic Survey among the Mahars of Nagpur district in 1958. The author as a member of the party while conducting the investigation in the Maher community of Kamptee town, Nagpur district, tested the blood specimens of the Raj Gonds living in the same town.

The town of Kamptee is situated in $21^{\circ} 13' N$ and $79^{\circ} 12' E$ and 10 miles away from Nagpur city.

Fifty-one unrelated Raj Gonds were tested for ABO groups. As no published blood group data on this people are available, the present material, although small, may give some information about the ABO gene composition of this population. Gene frequency has been evaluated according to the improved formulæ of Bernstein (1930) cited by Race and Sanger¹ (1954). The results are given in Table I.

TABLE I
ABO blood groups in the Raj Gonds of Kamptee town

Groups	Observed No.	Expected No.	Observed p.c.	Gene frequency	D/ σ
O	14	14.46	27.45	$p=0.105$	+0.921
A	7	6.25	13.73	$q=0.362$	
B	27	26.41	52.94	$r=0.533$	
AB	3	3.88	5.88	..	
Total	51	51.00	100.00	1.000	..

A very close agreement between the observed and the corresponding expected numbers of each phenotype and the D/σ value (+ 0.921) indicate the consistency of the data and the homogeneity of the sample.

Dept. of Anthropology, P. N. BHATTACHARJEE,
Govt. of India, Indian Museum,
Calcutta-13, February 18, 1961.

1. Race, R. and Sanger, R., *Blood Groups in Man*,
Blackwell Scientific Publications, Oxford, 1954.

"UREA-FORM"—A NEW FERTILISER

THE need for water-insoluble nitrogen that will release available nitrogen at rates approximating crop needs has been recognised. Natural "organics" have been used to meet this need but are not of much value in two respects. First most of the (available) nitrogen is converted to mineral form in a relatively short time. Second a very substantial percentage of the total nitrogen is not available (Yee and Love, 1946).¹ Furthermore most of the better grades of natural organics are used for livestock feed rather than for fertilizers and the unit price of nitrogen in natural organics is high. These considerations indicate the need for synthetic water-insoluble nitrogenous fertilizers with controlled rates of availability.

The alternative source of slowly available nitrogen is the "urea-form" which is the name assigned to the urea-formaldehyde reaction products. These products have high percentage of nitrogen (37–41%) depending upon the mole ratio of the reactants. As the mole ratio of the reactants is brought higher than unity, the solubility as well as the availability of the nitrogen of the products increases. The development of these suitable organic materials offers the possibilities of greater uniformity of the products. Still further interest would be a range of graded products having different rates of decomposition in the soil. The fertilizers could thus be selected to suit a particular crop.

There are several procedures for the preparation of urea-formaldehyde. Clark, Yee and Love (1946)² and Owen (1946)³ have followed the method of reacting concentrated solution of urea with formaldehyde maintained at a suitable pH. The reaction is quite rapid and a lot of heat is evolved. The reaction product is a solid mass which can be dried and powdered. In the present work the procedure of the above workers was adopted. A list of the urea-formaldehyde

compounds prepared in the laboratory is given in Table I.

TABLE I

Sl. No.	Fertilizer	U/F mole ratio	Nitrogen %
1	U.F.A.	..	6.75
2	U.F.B.	..	3.37
3	U.F.C.	..	2.23

The above products were subjected to the following tests for evaluating their slow acting nature.

(1) *Activity Index Test*.—This test applies only to urea formaldehyde compounds. This was carried out according to the procedure given in A.O.A.C. (1955).⁵

(2) *Pot Culture Experiment*.—Pots of 20 lb. capacity were used for conducting this experiment. They were filled with the surface soil obtained from Top Block A of Agronomy Division. Rice was grown during Kharif (1958) and the nitrogen was applied at the rate of 200 lb. N per acre.

In Table II are given yield data obtained in the case of rice crop. The data indicate that the effect of urea-formaldehyde on the yield of rice is as good as that of standard fertilizers urea.

TABLE II

Sl. No	Fertilizer	Replication				Average
		1	2	3	4	
1	Urea	68.00	66.00	69.50	74.00	69.30
2	U.F.A.	62.80	64.00	67.00	62.50	64.00
3	U.F.B.	65.50	68.50	65.99	72.00	72.40
4	U.F.C.	46.50	53.00	59.00	52.00	52.60
5	Control	16.00	16.00	19.70	18.00	17.40
C.D. at the rate of 5% — 27.53						
C.D. at the rate of 1% — 38.60						

The data were statistically examined and the results were found to be significant at 5% level. Urea and the other urea-formaldehyde reaction products, e.g., U.F.A., U.F.B., and U.F.C. were found to give significant increase over no manure but they were found to be insignificant over one another. Such a behaviour was anticipated as these products have fairly high solubility and nitrifiability. The above observations are in conformity with the observations of Armiger *et al.* (1948).⁴ They found that the rate at which the nitrogen becomes available for crop growth increases as the urea-form mole ratio increased. So it can be said that the urea-form products of higher U/F mole ratio are as efficient as standard fertilizer urea.

Indian Agricultural Research
Institute,
New Delhi, January 31, 1961.

S. N. DATTA.
V. ISWARAN.
A. K. RISHI.

1. Yee, J. V. and Love, K. S. *Proc. Soil Soc. Amer.*, 1946, 11, 389.
2. Clark, K. G., *Jour. Agr. Fd. chem.*, 1946, 4 (2), 135.
3. Owen, O., *Jour. Sci. Fd. and Agri.*, 1946, 3, 531.
4. Armiger, W. H., *Jour. Amer. Soc. Agron.*, 1948, 40, 342.
5. A.O.A.C., *Association of Official and Agricultural Chemists*, 1955.

VANADIUM-BEARING TITANIFEROUS MAGNETITES NEAR TIRUVUR, KRISHNA DIST., ANDHRA PRADESH

THE Eastern Singhbum and Nausahi in Keonjhar District of Orissa are the only places where the occurrence of Vanadiferous titaniferous magnetite ores has been reported. Dunn¹ described the different types of the magnetite ores of the former area; Ghosh and Prasada Rao² reported on those of the latter area; Mukherjee³ and Chakravarti⁴ have made a detailed mineralographic study of the Nausahi ores.

The author had an occasion to study the iron ore bodies found near Kommireddipalle, a small village, 7 miles south-west of Tiruvur in Krishna District. These ores proved to be vanadiferous when they were analysed later in the laboratory.

The vanadium-bearing magnetite occurs as a dyke in the basic charnockites which are intrusive into the khondalites. The ore body is about 500 ft. long and 50 ft. wide striking N.N.W.-S.S.E. with an easterly dip of 80°. As a result of weathering the outcrop of the main lode has been disintegrated into massive boulders, loose and gritty material, float ores and placer sands. The existence of the dyke has been revealed by a detailed prospecting and magnetic survey.

Vanadium determinations have been carried out on all types of the ore and the percentages of vanadium pentoxide and titanium oxide are found to vary in different types of ores as shown below :

Type of ore	V ₂ O ₅	TiO ₂
Hard ore	1.875	13.60
Gritty ore	0.670	14.36
Soft ore	1.340	15.20
Float ore	1.785	13.80

The ores have been studied under the ore microscope. They consist of magnetite, ilmenite, hematite, maghemite, martite, rutile and goethite. No vanadium mineral is identified but both

magnetite and hematite respond readily to the spot⁵ and fluorescence⁶ tests for vanadium. Vanadium may be occurring here as vanado-magnetite and vanado-hematite in solid solution with magnetite and hematite. Some important textures found in these ores are (1) crystallographic intergrowth of magnetite-ilmenite; hematite-ilmenite; (2) granular intergrowth of magnetite and ilmenite and (3) replacement textures.

The paragenetic sequence of the minerals from the earliest to the latest is : intergrown magnetite-ilmenite, ilmenite, maghemite, martite, hematite (β), goethite and rutile.

From a correlation of the mode of occurrence of the magnetite lode with the ore microscopic studies, it is suggested that the vanadium-bearing titaniferous magnetites of the Tiruvur area have originated through the process of late magmatic accumulation and injection.

The details of field and mineralographic studies will be published elsewhere.

The author desires to express his grateful thanks to Prof. C. Mahadevan for many helpful discussions throughout the work.

Department of Geology, K. KAMESWARA RAO.
Andhra University,
Waltair, February 4, 1961.

1. Dunn, J. A., *Mem. G.S.I.*, 8, 69, 193.
2. Ghosh, A. M. N. and Prasada Rao, G. H. S. V. *Rec. G.S.I.*, 1952, 82, Part 2.
3. Mukherjee, S., *Quart. Jour. Geol. Min. and Met. Soc. of Ind.*, September 1958, 108.
4. Chakravarti, K., *Proc. of Nat. Inst. Sci. Ind.* September 1959, 25, 262.
5. Panduranga Rao, V. and Gopala Rao, G., *Ziel Schrift fur Analytische Chemie*, 1957, 2, 100.
6. — and —, *Ibid.*, 1958, 6, 109.

KYUSHU EARTHQUAKE—GRAVITY RECORD AT HYDERABAD

IN an earlier paper,¹ the authors have drawn attention to how earthquake shocks influence a gravimeter spring. Since then, we have designed and set up an automatic recorder in this laboratory for recording the change in gravity value with time. The recording device is of an optical type where the light beam from an external source falls on the mirror of a moving coil galvanometer which is connected to the gravimeter. The variation in gravity with time as shown by the gravimeter is noticed by observing the movement of the galvanometer mirror, and this is recorded on a photographic paper round a drum driven by a clock-work mechanism. We are able to cover periods of 12 hours continuously at a time with this arrangement. The

record obtained on the night of 26/27 February 1961 (Fig. 1) shows a great disturbance at about 23 hours 50 minutes which gradually died out.

earthquake that evening at the same time (23 hours 50 minutes). Available information tells us that the shock occurred at a distance of about 5,600 km. in a direction exactly 45° East of

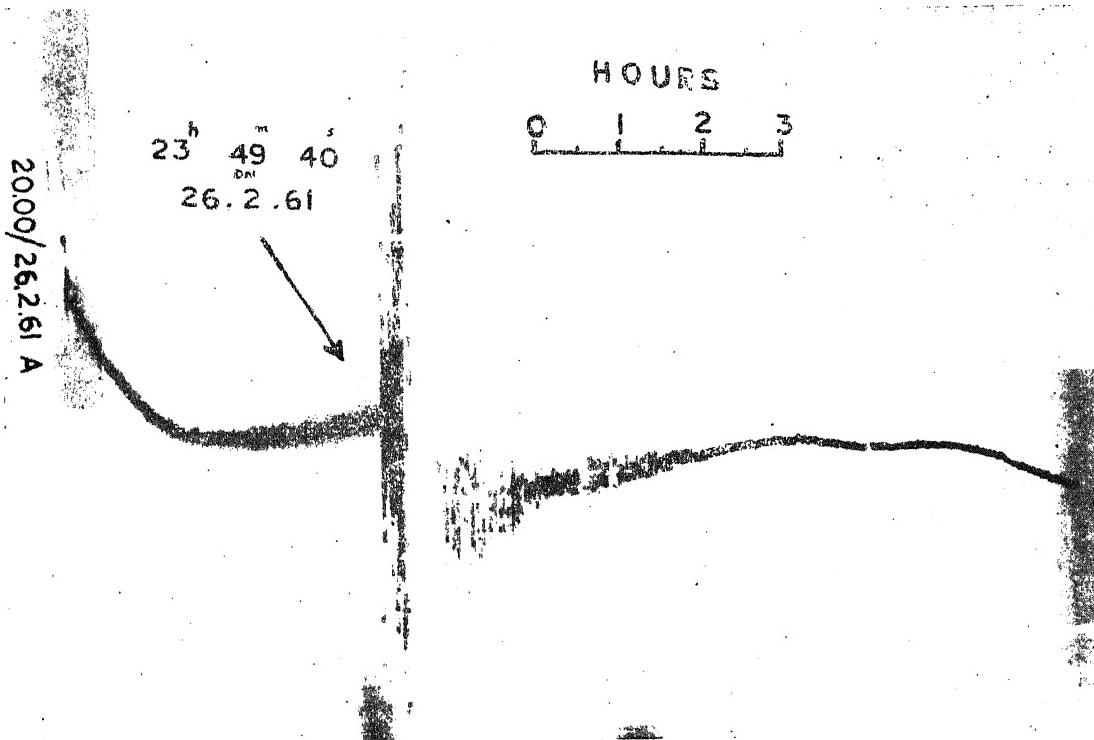


FIG. 1. Gravity Record from 20.00 hrs./26-2-1961 (A) to 08.00 hrs./27-2-1961 (B).

The seismic records (both N-S and E-W components) obtained from the Nizamia Observatory at Hyderabad (Fig. 2) indicate an intense

North, the epicenter of which was located off-shore South-East of Kyushu, the southernmost island of the Japanese group. The interesting point about the seismic records is the similarity between the two components inasmuch as the intensity is same in both and there is a marked correspondence in the phase of the record in both the components. This is presumably so because the earthquake occurred in a direction midway between North and East.

The gravity record shows other interesting features. In addition to the high frequency of great amplitude, a long-period vibration of a period slightly less than an hour (50-55 mins.) seems to be present in the curve besides a two-hour period. However, this can be confirmed only after complete analysis of the data. The striking feature of the observation is that the gravity record we have now obtained is at a station far removed from the epicenter. Both the seismic and gravity records stand nicely correlated and suggest that any disturbance due to an earthquake shock and presumably also

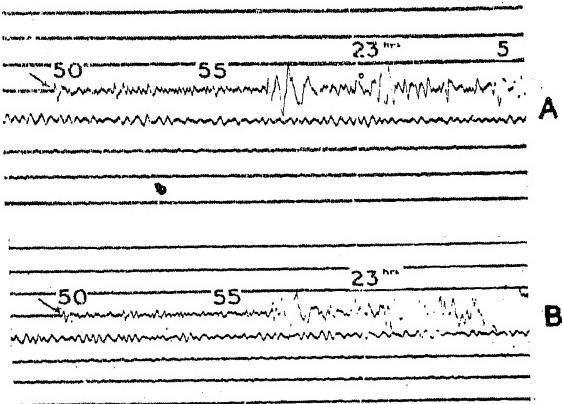


FIG. 2. Seismic Records. A. E-W Component and B. N-S Component arrows indicate first earthquake shock at 23 hrs., 49 mins., 40 secs. on 26-2-1961.

the long-period vibration of the earth may be recorded successfully.

A close examination of the gravity and seismic records obtained from neighbouring observatories with reference to particular earthquake will enable us to know the local geological structure. It appears also that the long-distance earthquakes can be made use of in a similar fashion for delineating the Mohorovicic layer in an area. All the above ideas and suggestions are shared by Prof. Masami Hayakawa of the Geological Survey of Japan who was present at Hyderabad when the record was obtained and the authors are grateful to him for the discussion they had with him.

A detailed analysis and the application of the data to the interpretation of the underground structure will be taken up later in a fuller communication.

Geology Department,
Osmania University,
Hyderabad, March 20, 1961.

S. BALAKRISHNA.
P. V. JOHNSON.

1. Balakrishna, S. and Johnson, P. V., *Curr. Sci.*, 1960, **29**, 476.

NITROGEN CONTENT OF TWO SPECIES OF WOOD-BORING MARTESIA OF MADRAS

THE total nitrogen content of several Molluscs have been studied (Vinogradov¹ for earlier literature; Lasker and Lane²; Greenfield³) but systematic studies of particular species in relation to season and age are meagre except for those on *Teredo pedicellata* (Greenfield³). Greenfield³ and Lasker and Lane² have reported that the nitrogen content of Teredines is low and that they derive their requirements both from wood and suspended planktonic organisms. It was felt that a comparative study of the nitrogen content in relation to size of the marine wood-boring pholads *Martesia striata* and *Martesia fragilis* not attempted before would be of interest.

Total nitrogen of *M. striata* and *M. fragilis* collected in the Madras coast were determined by the usual Microkjeldahl method (Steyermark⁴).

The total N of *M. fragilis* increases with increasing body weight, i.e., it is 0.1157 mg. in an animal weighing 3 mg. (wet weight) and gradually increases until it is 1.26 mg. in animals weighing 61 mg. (Fig. 1). This amounts to 3.85% to 2.06% of the wet weight. The unit nitrogen content shows a slight but gradual decrease with increase in body weight although

there is considerable fluctuation. The dry matter was only a fifth of the total weight and on the basis of the dry weights the nitrogen content varied from 10.3% to 19.25%. In *M. striata* on the other hand the nitrogen content varied from 3.7 mg. in 94 mg. of tissue (3.93%) to 13.35 mg. in 534 mg. (2.28%). As in *M. fragilis* there is a fall in N content per unit weight with an increase in body weight.

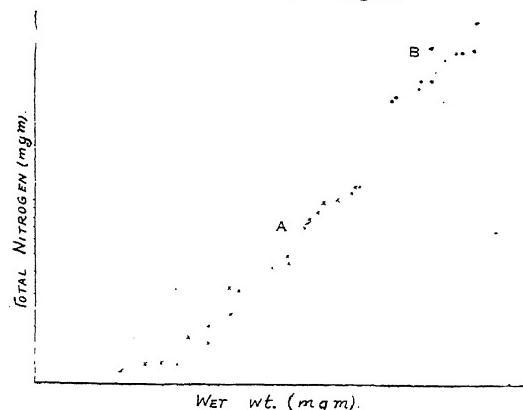


FIG. 1. Double logarithmic graph showing the Total N content of (A) *Martesia fragilis* and (B) *Martesia striata* in relation to their body weight.

M. striata which occurs in the piles and other fixed structures of the harbour possesses higher N content (mean values) than *M. fragilis* which is mainly a pelagic form. The mean N content of *M. striata* is 3.18% of living matter and 15.90% of dry matter and that of *M. fragilis* is 2.37% of living matter and 11.85% of dry matter. From the data, it is seen that the mean N content per unit weight of *M. striata* is about 1.34 times more than that found in *M. fragilis*. The N values of the wood-boring Teredines *T. bartschi* (Lasker and Lane²) and *T. pedicellata* (Greenfield³) varies only from 1.77% to 2.17% of the dry matter and is low when compared to those of the filter-feeding lamellibranchs and the wood-boring pholads. The N values of the latter are comparable to those of the filter-feeding lamellibranchs (*Mytilus edulis*, *Ostrea edulis*, *Mya arenaria*, and *Pecten irradians* Vinogradov¹) which are known to vary from 2 to 2.36%. *M. fragilis* and *M. striata* are also active filter-feeders like those forms possessing extensive ctenidia and labial palps with powerful ciliary sorting mechanisms for a mode of feeding which is predominantly planktonic. Further the animals are capable of living outside wood for a considerable length of time. They also resemble in their anatomical features the rock-boring pholads than the wood-

boring Teredines (unpublished observations). Hence the N requirements are mainly from plankton which is qualitatively richer in its nitrogen content than cellulose (Lasker and Lane²) from which *Teredo* derives part of its requirements. This probably implies that Martesia like other filter feeding lamellibranchs are metabolically more active than the wood-boring teredines.

I thank Dr. S. Krishnaswamy for suggesting the problem and guidance and the Forest Research Institute, Dehra Dun, for financial assistance.

Zoology Research Lab., V. V. SRINIVASAN.
Univ. of Madras, February 7, 1961.

1. Vinogradov, A. P., *Mem. Sears. Found. Mar. Res.*, 1953, No. 2.
2. Lasker, R. and Lane, C. L., *Biol. Bull.*, 1953, **105**, 316.
3. Greenfield, L. J., *Bull. Mar. Sci.*, 1953, **2**, 486.
4. Steyermark, A., *Qualitative Organic Microanalysis*, Blackiston & Co., Philadelphia, 1951.

A NEW SPECIES OF CYLINDROCLADIUM PARASITIC ON TEA ROOTS

A NEW tea root disease caused by a species of *Cylindrocladium* was described from South India a few years ago¹ and it was then reported that the fungus did not correspond to any of the hitherto described species of the genus.

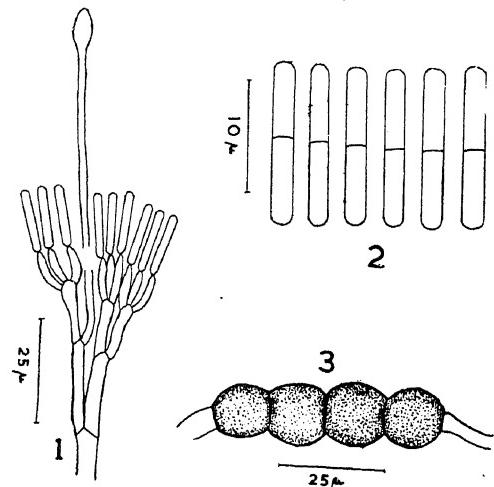
The species of *Cylindrocladium* are separated mainly on the basis of their conidial size, the smallest conidia being known to be produced by *C. parvum* Anderson.² Both on the plant material and on potato-dextrose agar, the fungus isolated by us produces conidia ($11-15 \times 1.85 \mu$) which are smaller than those of *C. parvum* ($15-21 \times 2.3 \mu$). The apex of the sterile filament is also different in shape from that of the other known species. We, therefore, place this fungus in a new species which we propose naming *Cylindrocladium camelliae*.

Cylindrocladium camelliae Venkataramani & Venkata Ram sp. nov.

Mycelium primo hyalinum, demum ochraceum; chlamydosporae producuntur intercalariter subcultura. Conidiophori erecti, ramis singulis, binis vel ternis lateralibus, quorum-singuli desinunt in phialides ternas, quibus conidia insidunt: axis principalis conidiophori vulgo efformat filamentum longum desinens in bulbum ellipticum ($9.25 \times 3.7 \mu$). Conidia cylindrica, recta, obtusa, semel septata, 11-15 (vulgo 13-15 μ) $\times 1.85 \mu$ (raro 2.0 μ).

Mycelium hyaline when young and later turning ochraceous; intercalary chlamydospores produced in culture. Conidiophores erect with

one, two or three lateral branches, each ending in two or three phialides on which conidia are borne singly; main axis of conidiophore mostly forming a long filament terminating in an elliptical knob ($9.25 \times 3.7 \mu$). Conidia cylindrical straight, obtuse, 1-septate, 11-15 (mostly 13-15 μ) by 1.85μ , seldom 2.0 μ (Figs. 1-3).



FIGS. 1-3. *Cylindrocladium camelliae*. Fig. 1. Conidiophore with the main axis forming a long filament terminating in an elliptical swelling. Fig. 2. Conidia. Fig. 3. Intercalary chlamydospores formed in culture.

Habitat—parasitic on roots of *Camellia sinensis* (L.) O. Kuntze.

A specimen of the diseased tea root material has been deposited in the herbarium of the Commonwealth Mycological Institute, Kew, under the number I.M.I. 47717 and the type culture of the fungus is being maintained in the culture collection at the UPASI Tea Experiment Station.

Since the first report of the disease,¹ we have recorded this fungus on a few occasions on roots of tea plants of different ages received from various localities in South India. An apparently identical disease has also been reported recently from the Mauritius (Orieux, 1957, personal communication).

We thank Rev. Fr. Dr. H. Santapau, for the Latin description of the species.

UPASI Tea Experiment K. S. VENKATARAMANI.
Station, C. S. VENKATA RAM.
Devarshola P.O., Nilgiris,
February 8, 1961.

1. Venkataramani, K. S., *Nature*, 1952, **169**, 1099.
2. Boedijn, K. B. and Reitsma, J., "Notes on the genus *Cylindrocladium*," *Reinwardtia*, 1950, **1**, 51.

**THE POTATO ROOT-EELWORM
HETERODERA ROSTOCHIENSIS WOLL.
IN INDIA**

DURING a recent visit to Ootacamund, Madras State, several potato fields at an elevation of over 7,000 ft. above sea-level were examined. One field was lightly infested with the potato root-eelworm or golden nematode, *Heterodera rostochiensis* Woll. Spherical females in the white, golden and brown stages were observed adhering to potato roots and, when stained in cotton blue-lacto phenol (Goodey, 1957), earlier stages and males were found within them. Cysts extracted from the soil by flotation (Goodey, 1957) agreed with specimens from Great Britain in size, shape, colouration, cuticular pattern and in the arrangement of vulva and anus (Hesling, 1958, Goffart, 1960).

So far as I am aware, this is the first record of *H. rostochiensis* in India. A number of references to "potato root-eelworm" occur in the literature but these are to *Meloidogyne* spp. on potatoes. Between *Heterodera* and *Meloidogyne* there is much unnecessary confusion: the horny cysts of the former are quite distinct from the thin-walled, saccular females of the latter. Females of *Heterodera* adhere to the root systems of their hosts with only the head and neck embedded whereas those of *Meloidogyne* are usually embedded in prominent root galls.

The natural home of *H. rostochiensis* is thought to be the South American Andes where it occurs under the cool conditions afforded by high altitudes (Bell, F. H. and Allandia, B. S., 1955; Krusberg, L. R. and Hirschmann, H., 1958). The *H. rostochiensis* at Ootacamund may have been introduced in potatoes from Britain: European weeds such as chickweed, *Stellaria media* and spurry, *Spergula arvensis* also occur in the fields.

Botany Department, F. G. W. JONES.
Muslim University, Aligarh,¹
March 9, 1961.

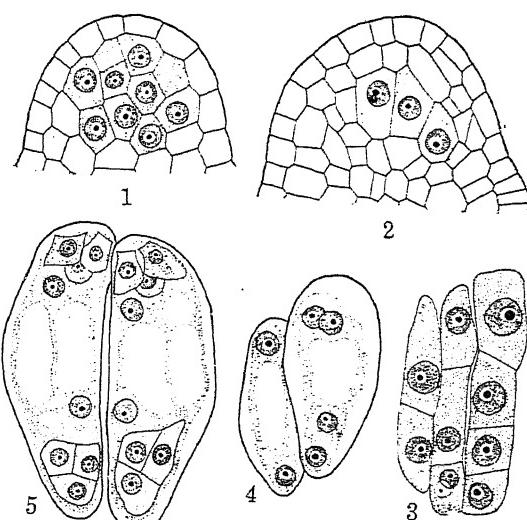
* Visiting worker from Rothamsted Experimental Station, England.

1. Bell, F. H. and Allandia, B. S., *Plant. Dis. Rept.*, 1955, **39** (5), 407.
2. Goffart, H., *Mit. biol. Bund. Anst. Berl.*, 1960, **99**, 24.
3. Goodey, J. B., *Min. Agr. Fish. Tech. Bull.* No. 2, H.M.S.O., London, 1957.
4. Hesling, J. J., "The identification of *Heterodera* cysts. In *Plant Nematology*, Ed. J. F. Soutney," *Ibid.*, No. 7, 1959.
5. Krusberg, L. R. and Hirschmann, H., *Plant Dis. Rept.*, 1958, **42**, 599.

**OCCURRENCE OF TWIN EMBRYO-SACS
IN *CAPPARIS APHYLLA* ROTH.**

WHILE studying the life-history of *Capparis aphylla* Roth., a sturdy xerophyte growing wild round about Ahmednagar, the author came across many ovules showing twin embryo-sacs. The present note describes their mode of development.

The female archesporium in *Capparis aphylla* Roth., is multicellular consisting of hypodermal and subhypodermal cells (Fig. 1) unlike in other members of the family where it is reported to be unicellular (Rao, 1936; 1938).^{1,2} During development two or three megasporangia develop frequently side by side (Fig. 2) to form tetrads of diverse types (Fig. 3). The selection of the megasporangia is of the fixed type. The chalazal megasporangium always develops into the embryo-sac of the Polygynum type (Maheshwari, 1950).³ In many cases the two chalazal megasporangia of the adjoining tetrads develop simultaneously resulting in two embryo-sacs in a single ovule (Fig. 4). Such embryo-sacs may or may not be at the same stage of development. One on the right is 4-nucleate while the other is 2-nucleate. Figure 5 shows two



FIGS. 1-5. Fig. 1. L.S. apex of nucellus showing hypodermal and subhypodermal archesporium. Fig. 2. The same as above showing three functional megasporangia. Fig. 3. Megasporangia tetrads. Figs. 4 and 5. Twin embryo-sacs, $\times 1,800$.

mature embryo-sacs each one showing an egg apparatus at the micropylar end, two polars and three antipodal at the chalazal end. The structure of the egg apparatus in both the sacs is of the usual type. It is likely that these

functional eggs might develop into embryos after fertilization leading to polyembryony (Johansen, 1950).¹

The author is grateful to Dr. L. B. Kajale, Principal, College of Science, Nagpur, for guidance and criticism. Thanks are also due to Shri M. D. Padhye for his kind help and to Principal, T. Barnabus, for his keen interest and facilities.

Botany Department,
Ahmednagar College, Ahmednagar,
January 3, 1961.

1. Rao, V. S., *J. Indian Bot. Soc.*, 1936, **15**, 335.
2. —, *Ibid.*, 1938, **17**, 69.
3. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, New York, 1950.
4. Johansen, D. A., *Plant Embryology*, U.S.A., 1950.

SEGREGATION FOR LANKY AND NORMAL SEEDLINGS IN SORGHUM

In the F₂ progeny of a cross between A. 6697 (male sterile sorghum from U.S.A.) and I.S. 1032 (early prodigy from Madhya Pradesh) segregation for lanky and normal seedlings was observed though the seedlings in both the parents and F₁ hybrid were normal.

In the segregating progeny, the lanky seedlings were tall and slender with long and narrow leaves. When 15 days old the average height of the lanky seedlings was 17.7 cm. (S.E. = 2.1; range 15 to 20 cm.) while the average height of normal seedlings was 4.7 cm. (S.E. = 0.64; range 4 to 6 cm.) and the leaves were short and wide. When compared with the normal seedlings the lanky seedlings were of lighter-green colour and the root system was also ill-developed. Node formation was well advanced exposing the first node. The differences between these two types of seedlings are shown in Fig. 1.

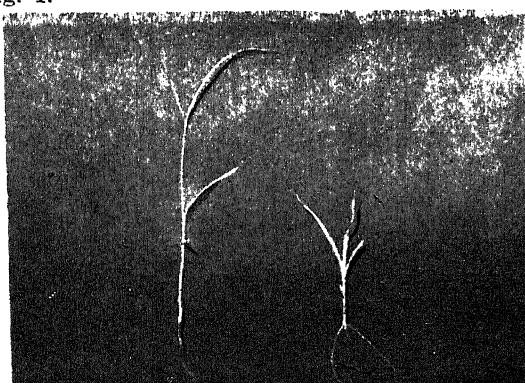


FIG. 1. Left : Lanky Seedling.
Right : Normal Seedling.

The data of the lanky and normal seedlings in F₂ generation are given in Table I.

TABLE I

	Normal	Lanky
Observed ..	286	92
Expected on 3 : 1 ratio ..	283.5	94.5

$$X^2 = 1.105, P \text{ between } 0.20 \text{ and } 0.30.$$

The goodness of fit test for 3 : 1 ratio is satisfied indicating that the character for lanky producing normal seedlings. The occurrence of lanky seedlings may be attributed to a mutation in the heterozygous material. Being recessive this character has not manifested itself in the F₁ generation.

A.R.S. Lam,
Guntur-2,
December 22, 1960.

C. SREERAMULU.
S. RAMACHANDRARAO.

CALLUS HAIR LENGTH AND ARROW COLOUR IN CERTAIN INTER-GENERIC HYBRIDS OF SACCHARUM

THE length of callus hair in relation to the length of the spikelet is known to be a stable character in the species of *Saccharum* and its allied genera *Narenga porphyrocoma* (Hans. Bor) and *Sclerostachya fusca* (A. Camus). The callus hairs are about 3 times as long as the spikelet in *S. officinarum* while they are about 3½ times the length of the spikelet in *S. spontaneum*. In *Narenga* they are just as long as the spikelet while in *Sclerostachya* they are only half the length of the spikelet.

A large number of F₁ hybrids (as many as 500) of the intergeneric crosses with the species of *Saccharum*, namely *S. officinarum*, *S. robustum* and *S. spontaneum* as pistillate parents and the two allied genera, *Narenga* and *Sclerostachya*, as staminate parents were studied for the character, length of callus hair. It was found that the length of the callus hair ranged from 1¼ to 1¾ times the length of the spikelet in *Saccharum* × *Sclerostachya* hybrids and 2 to 2¼ times the length of the spikelet in *Saccharum* × *Narenga* hybrids. Thus the callus hair in the hybrids were found to be intermediate and more or less about the mean of the two parents in length.

On the basis of the chromosome number Bremer¹ considered the variety Hitam Rokan (2n = 55) to be a possible hybrid between *S. officinarum* (2n = 80) and *Narenga* (2n = 30). The length of the callus hair in Hitam Rokan is 1½ to 1¾ times as long as the spikelet, a feature characteristic of *Saccharum* × *Sclerostachya* hybrids studied by the authors.

Judging from this character, it would appear that the impact of *Sclerostachya fusca* rather than of *Narenga* is more probable in the evolution of Hitam Rokan.

Observations were also made on the colour of the inflorescences in the parents and their F_1 hybrids. The colour of the arrows in *S. officinarum* and *S. robustum* is purplish-white and that in *S. spontaneum* silvery-grey, whereas in *Sclerostachya* and *Narenga* the colour of the arrows is burnished copper. It was found that in all the F_1 hybrids examined the colour of the arrows was burnished copper, indicating its dominance over purplish-white and silvery-grey. Incidentally the arrow colour in Hitam Rokan is also burnished copper.

The authors are grateful to Dr. N. R. Bhat, Director, Sugarcane Breeding Institute, Coimbatore, for helpful criticism and encouragement.

Sugarcane Breeding Institute, K. S. SUBBA RAO.
Coimbatore-7, P. A. KANDASAMI.
December 27, 1960. B. V. NATARAJAN.

1. Bremier, G., *Cytology of Sugarcane Genetica*, 1925,
Vol. 7.

MODE OF INFECTION IN SAWAN SMUT (*USTILAGO PARADOXA* SYD. AND BUTLER)

THE smut of *Echinochloa frumentacea* (Sawan plants) caused by *Ustilago paradoxa* has been shown to be externally seed-borne (Kulkarni, 1922 and Sharma, 1953).

As all the ovaries in an ear are not affected, as is the case in systemic infection, it was suspected that there might be localised infection of the blossom or the developing grains also. Infection trials were, therefore, carried out as follows :

Sawan plants of three different stages of maturity : (i) the early blossom stage (when the ears were just emerging); (ii) before anthesis, and (iii) in the stage of grain formation were inoculated with chlamydospores of *U. paradoxa* in January 1959, in plants raised in pots. The plants after inoculation were kept in a humid chamber for 48 hours. Observations were recorded after two weeks.

Ears inoculated in the early stages of ear emergence were completely smutted, whereas those inoculated in advanced stages of maturity (when the anthers and stigma were protruding) formed typical sori transforming the ovary into a grey round sac exceeding the size of the normal grain (Fig. 1). However, ears in the grain formation stage were not infected at all.

These facts are suggestive of the localization of infection in the developing ovary and its non-systemic nature.



FIG. 1 Ear on left completely smutted. Ear on the right with typical smut sori. ovary transformed into round grey sac slightly exceeding the size of the normal grain.

Further studies are in progress to see whether this mode of infection is common in nature.

Dept. of Plant Pathology, A. P. MISRA.
Bihar Agricultural College,
Sabour (Bhagalpur), December 15, 1960.

1. Kulkarni, G. S., *Jour. Indian Bot. Soc.*, 1922, **25**, 110.
2. Sharma, B. B., *Proc. 40th Ind. Sci. Congress*, Lucknow, 1953, 71, Part III.

CYTOGENETICS OF AN INTERSPECIFIC HYBRID IN ORYZA

CULTIVATED rice, *O. sativa* L., has been crossed with many wild species.¹ The present study deals with a hybrid (Fig. 1) between two wild

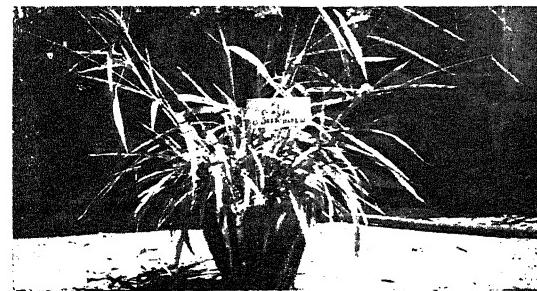


FIG. 1

$F_1 \frac{Oryza alta}{(2n=48)} \times \frac{Oryza officinalis}{(2n=24)}$

species, *O. alta* Swallen ($2n=48$) and *O. officinalis* Wall ($2n=24$), using the tetraploid species as female parent. The F_1 is a triploid with $2n=36$. The species *O. officinalis*

TABLE I

Character	<i>O. alta</i>	<i>O. officinalis</i>	<i>F₁ O. alta × O. officinalis</i>
Habit	.. Erect	Semi-erect	Semi-erect
Leaf size	.. Broad	Narrow	Nearer to <i>O. alta</i>
Ligule	.. Small with fringe of hairs at the apex	Small without fringe of hairs	Small with fringe of hairs
Colour of leaf sheath	.. Faint purple	Faint purple	Faint purple
Colour of nodal margins	.. Green	Purple	Green
Colour of auricle	.. Purple	Faint purple	Green
Colour of stigma	.. Green	Purple	Purple
Spikelets	.. Long and flattened	Small and flattened	Nearer to <i>O. alta</i>

is obtained from Ceylon and *O. alta*, through the courtesy of United States Department of Agriculture. The characters of the parents and the *F₁* are presented in Table I. It is interesting to note that the green colour which is generally recessive to purple colour is inherited as dominant in the present cross, in the case of the colour of the nodal margins, *O. alta* having green nodal margins. Another significant observation is that, whereas the auricle is purple in *O. alta* and faintly purple in *O. officinalis*, it is green in the *F₁* hybrid. The *F₁* is nearer to *O. alta* in plant height, leaf width, spikelet length and awn length. The pollen sterility in the hybrid is as high as 96% and the spikelets are totally sterile without any seed setting. The high gametic sterility could be due to the unbalanced chromosome complement consequent on the division of a triploid cell.

Cytological studies of the *F₁* hybrid showed that $2n = 36$ in the somatic cells. Meiosis was studied with the help of the smearing technique, acetic alcohol being used as a fixative and propionic-carmine as the stain. It was observed that 12 bivalents and 12 univalents were formed regularly. At metaphase, 12 bivalents arrange to form the equatorial plate and 12 univalents are irregularly distributed at the poles. A few trivalents were also seen in a considerable number of cells, but no quadrivalents. The regular formation of 12 bivalents and 12 univalents at the metaphase of the *F₁* hybrid suggests that one of the two genomes of *O. alta* is homologous with the genome of *O. officinalis*, hence if the genome of *O. officinalis* is designated as O_1O_1 , that of *O. alta* could be O_1O_1 , O_2O_2 , suggesting that *O. alta* might have originated from *O. officinalis* through hybridization and polyploidy.

Central Rice Research Institute,
Cuttack-4, November 3, 1960.

R. H. RICHHARIA,
D. V. SESHU.

1. Ghose, R. L. M., Ghatge, M. B. and Subramanyan, V., *Rice in India*, I.C.A.R., New Delhi, 1956.

A CONTRIBUTION TO THE EMBRYOLOGY OF *KNOXIA CORYMBOSA* WILLD.

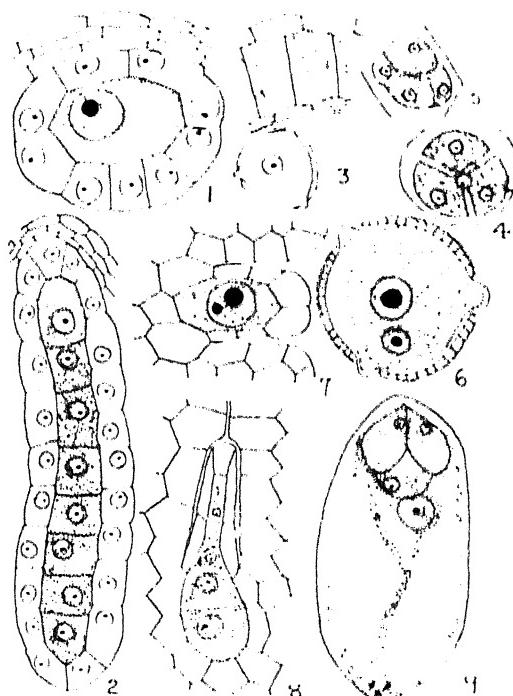
THE members of the family Rubiaceæ display features of embryological interest. Although extensive embryological investigations have been carried out in several genera of this family, the Indo-Malayan genus *Knoxia* remains uninvestigated. The material for the present investigation was collected round about Bangalore and Londa (Western Ghats).

The flowers are subsessile and are arranged in corymbose cymes. Flowers are tetramerous, bisexual and epigynous.

A single row of microspore mother cells is surrounded by the tapetum, two-wall layers and epidermis in each anther lobe (Figs. 1-2). The tapetal cells are glandular and remain uninucleate throughout, as in *Oldenlandia corymbosa* (Farooq, 1958). At maturity the endothecium exhibits the usual fibrous thickenings (Fig. 3). The microspore mother cells by meiotic divisions give rise to microspores which are usually tetrahedral but occasionally decussate in arrangement (Figs 4 and 5). The meiotic divisions of microspore mother cells in the same anther are often not synchronous. The pollen grains are triporate with a thick smooth exine and a thin intine. The mature pollen grains are two-celled (Fig. 6).

Two pendulous ovules arise from the tip of the central column within a bicarpellary syn-ovary and grow downwards towards the base of the ovarian cavity. Further growth on one side causes the ovules to simulate circinotropous condition. The ovules are tenuinucellate with a single massive integument. The nucellar epidermis is made up of five to six cells and conforms to the Phyllis type in the reduction series of the nucellus (Fagerlind, 1937). A single hypodermal archesporial cell directly functions as the megasporangium mother cell (Fig. 7) as in *Dentella repens* (Raghavan, T. S. and Rangaswamy, K. 1941). The megasporangium mother cell by meiotic divisions gives rise to linear

tetrad of megasporangia (Fig. 8). The megasporangia do not display the peculiar haustorial behaviour as in some members of the Rubiaceae (Fagerlin, 1937). The nucleus of the functioning chalazal megasporangium by three successive divisions gives rise to an eight-nucleate embryo-sac of the Polygonum type. The synergids neither exhibit filiform apparatus nor are they hooked. In the fully organised embryo-sac the secondary nucleus remains close to the egg (Fig. 9). The antipodal cells do not display any abnormal behaviour as reported in some members of the Rubiaceae (Fagerlin, 1936 a, 1936 b and 1937).



FIGS. 1-9. Fig. 1. T.S. of young anther lobe showing a single microspore mother cell surrounded by the petunia, middle layer endothecium and epidermis, $\times 1000$. Fig. 2. L.S. of young anther lobe showing a single row of microspore mother cells, $\times 500$. Fig. 3. Portion of anther wall showing fibrillar endothecium, $\times 500$. Figs. 4 and 5. Tetrahedral and decussate arrangement of microspores, $\times 1500$. Fig. 6. Two-celled pollen grains, $\times 1500$. Fig. 7. L.S. of ovule showing hypodermal archesporial cell, $\times 1000$. Fig. 8. Lineal tetrad of megasporangia, $\times 1000$. Fig. 9. Mature embryo-sac, $\times 500$.

Our thanks are due to Prof. S. Shamanna for guidance, to Mr. V. S. Panth for kind help and to Rev. Fr. E. D'Souza, S.J., for encouragement.

Dept. of Botany,
St. Joseph's College,
Bangalore, April 22, 1961.

G. SHIVARAMIAH.
P. S. GANAPATHY.

1. Fagerlin, F., Svensk Bot. Tidskr., 1936 a, 30, 302.
2. —, Bot. Notiser, 1936 b, 577.
3. —, Acta Horti Bergiani, 1937, II, 195.
4. Farooq, M., J. Indian Bot. Soc., 1958, 3, 358.
5. Raghavan, T. S. and Raigawamy, K., Ibid., 1941, 20 (5), 341.

SOME OBSERVATIONS ON A ROOT-PARASITE—*AEGINETIA INDICA* LINN.

Aeginetia indica Linn., a root-parasite, is a purplish plant with small rhizomes bearing numerous, short, branched, coral-like roots. The flowers are large, solitary on the top of a naked scape. This root-parasite is reported to be found in a number of forest areas in and outside the Bombay Presidency. In all the standard floras the plant is reported without a definite mention of the host plants. Both Cooke (1903) and Hooker (1875) are silent on this point. Trimen (1895) in his flora of Ceylon mentions the plant as a parasite on various roots. According to Gamble (1916-34) the plant is apparently parasitizing the roots of many different plants, the names of which are not mentioned. Santapau (1955) in his contributions to the Botany of Dang Forests, Bombay State, remarks that it was not possible to trace the host plant. Even in the more recent publications on the flora of this region, a mention of the host plants is not made. As far as we are aware, there does exist a lacuna in our knowledge of the host-parasite relations in this species.

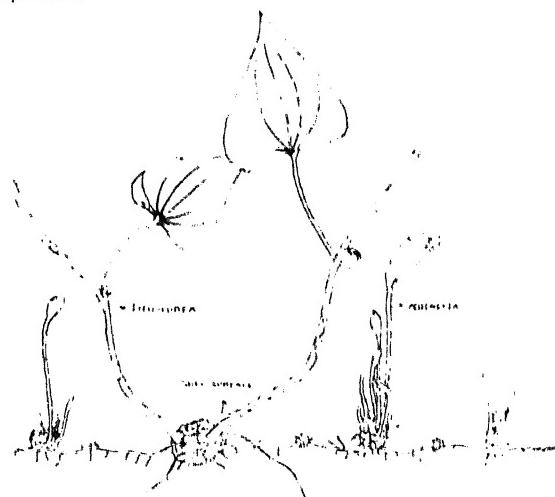


FIG. 1

This lacuna in the knowledge and the vagueness of the remarks made by some of the

previous workers prompted us to undertake a study of the nature of parasitism in this species, which, though not very common, is locally abundant on the Ratanmahal Hills (Banvra—450 meters above M.S.L., Panchmahal District, Gujarat State) by the side of a stream and on humus soils. Up till now even after great efforts, we have been able to trace only one host plant, viz., *Dioscorea* sp. and the other plants growing in the vicinity are apparently not parasitized. This very fact leads us to a conclusion that cosmopolitan nature of parasitism as reported by Trimen and Gamble may not be correct. In this connection we would welcome any other information gathered by workers in the country. We believe that *Dioscorea* sp. as a host plant for *Aeginetia indica* Linn. is reported for the first time.

As already observed by Rawat and Ambasht (1958) in the case of *Orobanche*, the roots of *Dioscorea* which were heavily parasitized also showed enormous length ranging from 122 to 183 cm., whereas the unaffected roots were comparatively very short and measured about 30 to 45 cm. It is rather premature to account for the anomalies in the growth of affected and unaffected roots, but it is hoped that from further studies in this direction a clearer picture of host-parasite relationship in this species, will emerge.

Department of Botany, A. R. CHAVAN.
M.S. University of Baroda, S. J. BEDI.
Baroda, January 27, 1961. S. D. SABNIS.

1. Cooke, T., *The Flora of Bombay Presidency*, London and Bombay, 1903-08, 2, 311.
2. Gamble, J. S., *Flora of the Presidency of Madras* (Reprint Edition) 1916-34, 2, 685, 1956
3. Hooker, J. D., *The Flora of British India*, 1875.
4. Rawat, V. S. and Ambasht R. S., 'Root relations of *Orobanche* and its host,' *Curr. Sci.*, 1958, 27, 445.
5. Samapau, H., *Contributions to the Botany of the Dangs Forests*, Bombay State, Guj. Res. Soc., Bombay, 1955, p. 6.
6. Tripathi H., *A Handbook of the Flora of Ceylon*, Part III, 1895, p. 261.

BEAN FLY, A SERIOUS PEST OF FRENCH BEANS

DURING 1952-53 it was found that French Bean seedlings (*Phaseolus vulgaris*) were wilting and the crop could not be grown successfully at Himayatsagar Farm, Hyderabad. An examination of the affected plants revealed the presence of small whitish maggots and yellowish puparia embedded in the stem. The insect causing the damage was identified as *Melanagromyzidae phaseoli* Coq. (Agromyzinae, Agromyzidae—

Diptera). This fly is known to cause considerable damage to cowpea in India. However, its attack on French Beans was not noted so far, from the former Hyderabad State, and for the first time this pest has been reported. Recently this insect has been found doing considerable damage to French Bean crop in the Delhi Territory also.

The general symptoms of the attack of *M. phaseoli* are the drooping and withering of leaves and finally wilting of the plant. In young plants the attack is characterized by the drooping of the first two leaves. The stems burst at or just above the ground level, where maggots and puparia concentrate and large calloused areas develop (Fig. 1). In older plants the



FIG. 1. Bean Fly infestation causing calloused and swollen areas on the French Bean stem at the ground level.

joints of branches are attacked and they droop, finally dying or breaking off during picking and other operations or strong winds.

Morgan (1938) and Caldwell (1939) have worked out the life-history of the fly in Australia.

Preliminary observations carried out at Himayatsagar Farm, showed that the eggs were laid on the leaves as soon as they appeared above ground. In the seedlings the larvae mined the leaves for 1-2 days and then tunneled down the leaf stalks to the base of stems, feeding at ground

level until they were mature. The tunnels were below the epidermal layer, which appeared as white streaks. The stem where maggots or puparia concentrated looked like a gall and the epidermis after drying became loose and could easily be removed, exposing the maggots or the puparia (Fig. 2). However, in older plants the

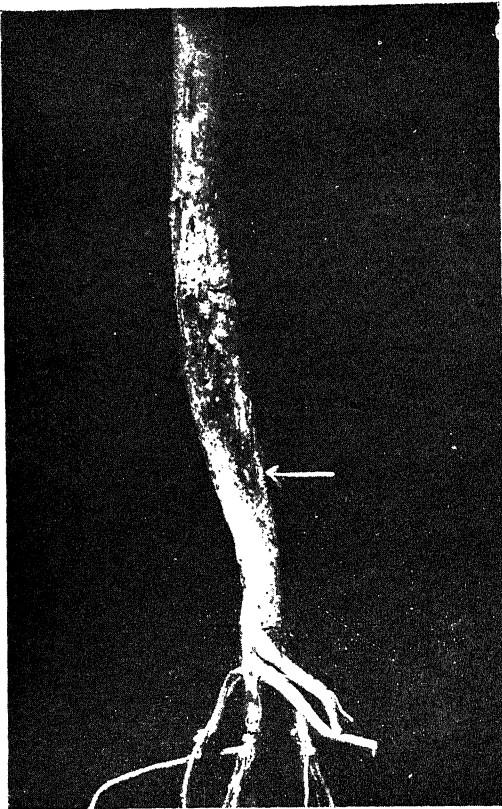


FIG. 2. Severely infested stem of French Bean; arrow indicating the position of puparia of *Melanagromyza phascoli*.

maggots could be found in the joints of branches and the leaf stalks, in which case only the attacked portion withered. The tunnelled branches easily broke off at the slightest touch, and the unaffected portions of the plant continued to flower and set fruits. The attack increased with the warmer weather.

Rarely single maggot was found in a plant. The maximum number of maggots obtained per plant was 8 and on an average 4-6 maggots were found in a stem. However, the number of maggots attacking the branches and the joints at a time was less. In cases of mild attack, plants put forth adventitious roots at or above the point of attack at the ground level and survived to yield a crop.

A chalcid parasite was reared out.

Preliminary trials at Himayatsagar Farm were conducted with the following insecticides applied as sprays at weekly intervals;

(i) Fish oil Rosin Soap at the rate of one ounce per gallon ; (ii) 0·03% Nicotine Sulphate ; (iii) 0·16% D.D.T. ; (iv) 0·03% Folidal and (v) 0·02% Lindane.

The results indicated that Nicotine Sulphate and D.D.T. were effective in reducing the infestation. Further trials are being carried out to evolve a suitable control schedule.

Extension Directorate, D. B. REDDY.
Ministry of Food and Agriculture,
New Delhi, December 24, 1960.

1. Morgan, W. I., *Agri. Gaz.*, N.S.W., 1938, 49, 22.
2. Cadwell, N.E.H., *Queensland Agri. J.*, 1939, 52
393.

THE RECORD OF PARASITIC NEMATODES OF SUGARCANE IN BIHAR

PARASITIC nematodes have been reported from abroad to cause injury to sugarcane crop. In India, the occurrence of parasitic nematodes in sugarcane appears to have been first reported by Srinivasan (1958), who found *Radopholus similis* (Cobb.), Thorne, associated with Chlorosis disease. The other species recorded from sugarcane are : *Meloidogyne* sp. (David, 1959), *Tylenchorhynchus* sp. and *M. javanica* (Treub.) Chitwood (Rangaswamy *et al.*, 1960) and *Helicotylenchus erythrinæ* (David and Thiruvengadam, 1960). The symptoms of attack of these species were stunting and chlorosis of infested plants.

The authors came across similar symptoms as reported by other workers in a sugarcane field at Pusa in March 1960. A detailed examination of the infested material revealed the presence of a few nematodes which are described below.

The material consisted of four species of parasitic nematodes belonging to the genera *Ditylenchus*, *Aphelenchoïdes*, *Hoplolaimus* and *Meloidogyne*. The specific determination of the first three genera could not be done due to the lack of adult stage in the collection, while the fourth was identified as *Meloidogyne javanica*. The species of *Hoplolaimus* has been considered as new species.

A few free living soil nematodes belonging to the genera *Disploscapter*, *Cephalobus*, *Dorylaimus* and *Cheiloplacus* were also found associated with the parasitic stock. Examples of *Aphelenchus avenæ*, which is considered as a

secondary parasite in necrotic situations, were also present in the collection.

The measurements of the specimens of *Hoplolaimus*, which has been considered to be a new species, are given as under (Fig. 1).

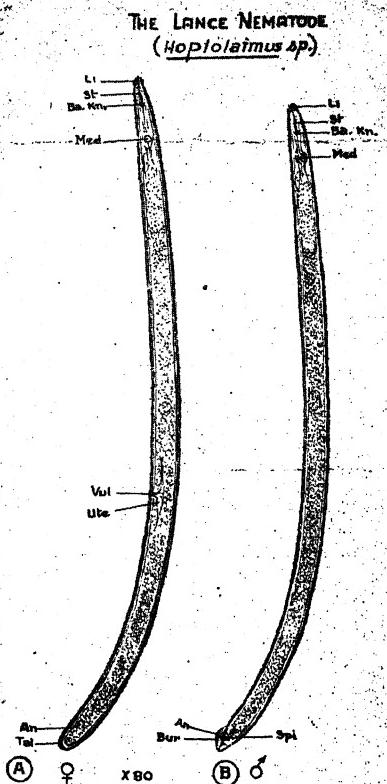


FIG. 1. *Li*, Lip; *St*, Stylet; *Ba*, *Kn*, Basal Knob; *Med*, Medium Bulb of Oesophagus; *Vul*, Vulva; *Ute*, Uterus; *An*, Anus; *Tal*, Tail; *Bur*, Buersa; *Spi*, Spicule.

♂—length 1.06–1.14 mm.; width 32–36 μ ; oesophagus 88–90 μ ; tail 26–28 μ and spear 36 μ .

♀—length 1.18–1.33 mm.; width 36–40 μ ; oesophagus 92–94 μ ; spear 36–40 μ and the distance of vulva from anterior end 650–700 μ .

So far, the parasitic nematodes in sugarcane have mostly been reported from South India but the observations by the authors show that these pests occur quite commonly in North Bihar. Recently, a new chlorotic disease has appeared in Bihar and Uttar Pradesh and a detailed study of these nematodes might help in determining the cause of this disease.

The authors are grateful to Rev. Father R. W. Timm, Nematologist, Notre Dame College,

Dacca, for kindly identifying the specimen reported in this paper. Thanks are also due to Dr. A. Ganguly, Sugarcane Pathologist, Pusa, for helping in these studies.

Sugarcane Research Inst., Z. A. SIDQUI.
Pusa, Bihar, A. R. PRASAD.
January 19, 1961. M. N. A. ANSARI.

1. Srinivasan, K. V., "A Pythium root rot and chlorosis complex of sugarcane," *Madras Agril. Jour.* 1958, 45 (3), 89.
2. David, H., "The root-knot nematode in sugarcane," *Ind. Jour. Sug. Res. & Dev.*, 1959, 3 (4), 234.
3. Rangaswami, C., Vasantrojan, V. N. and Venkatesan, R., "The occurrence of root-knot nematode in sugarcane and in some weeds," *Curr. Sci.*, 1960, 29 (6), 236.
4. David, H. and Thiruvengadam, C. R., "Eelworms in Sugarcane," *Proc. 4th Conf. Sug. Res. Dev. Workers*, India, Part I, Jan. 1960, 46.

CHROMOSOME NUMBERS IN THE GENUS *CURCUMA* LINN.

THE cytology of six species and several varieties of *Curcuma* has been investigated in the course of the present study. Cytological studies were made from acetocarmine smears of root-tips and anthers fixed in Carnoy's fluid. Root-tips were anthers fixed in Carnoy's fluid. Root tips were subjected to short periods of cold treatment prior to fixation.

The chromosome numbers determined in the present study and those reported previously in this genus are listed in Table I.

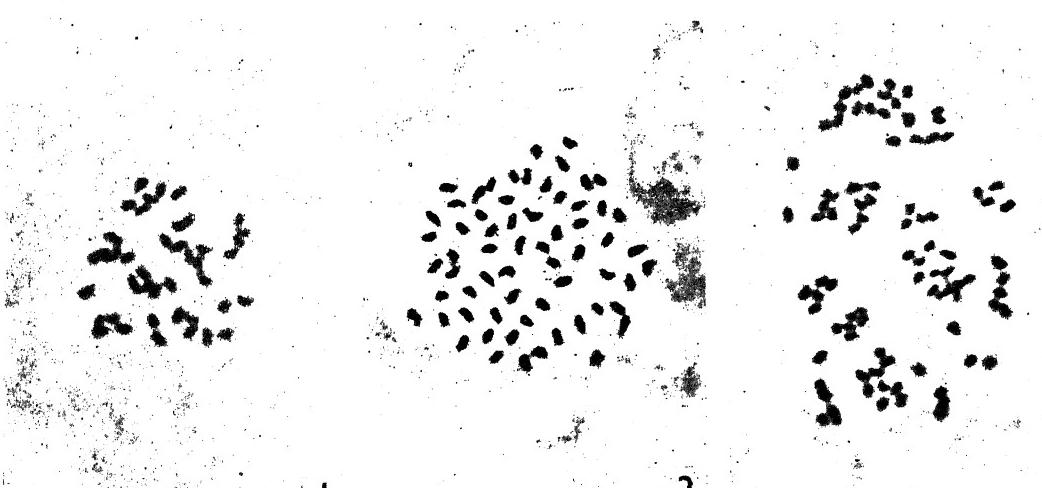
The chromosomes of all the species of *Curcuma* are small, between 0.6 μ and 1.7 μ in length. The basic number of the genus is 21. Evidently this is too high to be the primary one. It is possibly a secondary balance derived by amphidiploidy from a combination of 9 and 12 found in many genera of the Zingiberaceæ. Aneuploids, reported by others, were not observed among the triploid types of the present study. The two tetraploids of *C. aromatica* studied were aneuploids with 86 (84 + 2) chromosomes. $2n = 86$ is the highest number observed in this genus and is being reported for the first time.

Meioses in *C. decipiens* ($2n = 42$) and *C. longa* ($2n = 63$) have been studied in detail. In the former it is regular forming only bivalents at metaphase I. Meiosis in *C. longa* showed that it is an autotriploid, with a high percentage of trivalent associations, in spite of the small size of the chromosomes. The sterility of *C. longa* is due to its autotriploid constitution.

The presence of forms showing characters intermediate between *C. longa* and *C. aromatica* (both having $2n = 63$) shows that natural

TABLE I
Chromosome numbers in the genus Curcuma

Name	Source	Chromosome numbers ($2n$)	
		Present study	Previous observations
<i>Curcuma decipiens</i> Dalz.	..	Kerala	42 ..
<i>C. neilgherrensis</i> Wight.	..	"	42 ..
<i>C. amada</i> Roxb.	..	"	42 (Chakravorti ¹)
<i>C. zeodaria</i> Rosc.	..	"	42 (Sharma and Bhattacharyya ⁴)
<i>C. aromatica</i> Salisb.	..	"	64 (Venkatasubban ⁶)
" G. L. Puram type "	..	Turmeric Research Station, Pedapalam, Andhra	63 (Chakravorti ¹)
" Kasturi amalapuram "	..	"	42 (Raghavan and Venkatasubban ²)
" Polavaram "	..	"	..
<i>C. longa</i> Linn.	..	Kerala	63 ..
" Duggirala type "	..	Pedapalam	63 ..
" Kovvur Desavali "	..	"	63 ..
" Tekurpetta "	..	"	63 ..
" Types intermediate between <i>C. longa</i> and <i>C. aromatica</i> "	..	"	..
" G.L. Puram 2 "	..	"	63 ..
" Kasturi Duggirala "	..	"	63 ..
' Nallakatla pasupu '	..	"	63 ..
<i>C. angustifolia</i> Roxb.	..	"	42 (Chakravorti ¹)
<i>C. petiolata</i> Roxb.	..	"	42 (Sharma and Bhattacharyya ⁴), 64 (Venkatasubban ⁶)

FIGS. 1-3. Somatic chromosomes of *Curcuma* species. Fig. 1. *Curcuma amada*, $2n = 42$. Fig. 2. *Curcuma longa*, $2n = 63$. Fig. 3. *Curcuma aromatica*, $2n = 86$. (All figures, $\times 1,500$.)

crossing has occurred between these two species, or that one of these is evolved from the other by successive mutational steps, represented by these intermediate types. The herbaceous perennial habit of these plants, their vegetative mode of propagation and the small size of the chromosomes favour the perpetuation of polyploid types in this genus.

This work was carried out under a scheme of research on Miscellaneous Tuber Crops and Related Plants financed by the Indian Council of Agricultural Research. My thanks are due to Prof. A. Abraham, University of Kerala, for guidance, to Mr. S. Sangameswara Sarma, Research Officer, Turmeric Research Station, Pedapalam, Andhra, for supplying tuber materials of some of the types included in this study and to the University of Kerala for research facilities.

Department of Botany, K. RAMACHANDRAN,
University College,
Trivandrum, January 9, 1961.

1. Chakravorti, A. K., *Sci. and Cult.*, 1948 **a**, **14**, 137.
2. Raghavan, T. S. and Venkatasubban, K. R., *Proc. Ind. Acad. Sci.*, 1943, **17 B**, 118.
3. Sato, D., *Jap. J. Genet.*, 1948, **23**, 44.
4. Sharma, A. K. and Bhattacharyya, N. K., *La Cellule*, 1959, **5**, 299.
5. Sugura, T., *Mag. Tokyo*, 1931, **45**, 353.
6. Venkatasubban, K. R., *Proc. Ind. Acad. Sci.*, 1946, **23 B**, 281.

REACTION TO SHADOW IN *DASYCHONE CINGULATA* GRUBE. (POLYCHAETA)

AMONG the sedentary animals, many of the sabellids and serpulids have been found to respond to photic stimulation (*Sabella spalanzanii*, Loeb, 1903, 1918, Fox, 1938; *Hydroides dianthus*, Bohn, 1902; *Serpula vermicularis*, Hargitt, 1906; *Bispira volutacornis*, Hess, 1914; *Branchiomma vesiculosum*, Nicol,¹ 1950). In the common sabellid, *Dasychone cingulata*, Grube of the Madras harbour, Tampi² (1949) while describing the eyes made a reference to the shadow reaction in them. However no detailed analysis of this behaviour has been carried out so far. *Dasychone cingulata* Grube when kept in light shows two types of movements: (i) Complete retraction of the worm into its tube and (ii) movement of branchial crown or branchial filaments. The two types of movements are intermingled and consist of bursts of activity alternating with periods of rest. Of these, the withdrawal of the worm into its tube is the more prominent of the two. The spontaneous movements are greater at

higher intensities than in the lower intensities of light.

Although *Dasychone* responds to a decrease in intensity in a spectacular way, it is also found to respond to a sudden increase in intensity. But the worm gets rapidly adapted when the stimuli at short intervals continue and it ceases to respond.

The data obtained from thirty-seven animals showing response to shadow at intensities, ranging from 5 to 95 lux, point out that there is a tendency for the animals to respond more in the higher intensities of light than in the lower intensities (e.g., 48.7% at 5 lux as against 81.5% at 95 lux). Similarly, dark adapted forms are more sensitive than the light adapted forms. Again, adaptation to a certain intensity of illumination for a greater period of time results in a greater sensitivity to a passing shadow.

The intensity of illumination does not play a part in the emergence of the worms from their tubes, since 99.3% emerged, in one hour, at intensities ranging from 5 to 95 lux. The time taken for the emergence of the worms from their tubes, after contraction, varied between 1 min. 21.42 sec. at 5 lux and 52.8 sec. at 95 lux and the mean time of emergence was 1 min. 0.8 sec. Similarly, with the increase in intensity of illumination, there is also an increase in the number of times the animals contract and re-emerge.

The range of spectral sensitivity is wide in *Dasychone cingulata* Grube as shown by its responses to shadow in different coloured lights—especially more prominent in blue and yellow.

Though the evidence is not conclusive, the photoreceptors of the animal, do seem to play a part in the responses of *Dasychone cingulata* Grube to photic stimulation.

The details of this work will be published elsewhere.

I am much indebted to Dr. S. Krishnaswamy, Reader, Zoology Research Laboratory, for suggesting the problem, for guidance and encouragement. I am also thankful to Dr. C. P. Gnannamuthu, Director, for his interest in this work.

Zoology Res. Lab., R. THEODORE SRINIVASAGAM,
University of Madras,
Madras-5, February 6, 1961.

1. Nicol, J. A. C., "Responses of *Branchiomma vesiculosum* (Montagu) to photic stimulation," *J. Mar. Biol. Ass. U.K.*, 1950, **29**, 303 (and literature cited therein).
2. Tampi, P. R. S., "On the eyes of polychaetes" *Proc. Ind. Acad. Sci.*, 1949, **29B**, 129.

REVIEWS

Text Books in Mathematics. By Horace Lamb.
(Cambridge University Press, London, N.W. 1),
Dynamics: Pp. xi + 357. Price 18 sh. 6 d.
Statics: Pp. xii + 357. Price 18 sh. 6 d.

Lamb's books on Dynamics and Statics are well known to students of mathematics and have been in popular demand ever since their publication nearly fifty years ago. The present volumes are the ninth reprints of the revised editions of the 1920's. These books are not classics like the author's 'Hydrodynamics' but have served as useful text-books to graduate and honours students in mathematics. That reprints of the books were found to be desirable as well as profitable to the publishers, even in this decade, is a clear indication of both the popularity of the book as well as the sad plight of the syllabus in universities, that refuses to introduce newer developments or a more modern presentation. The paper cover editions issued at cheap price (by present standard) will be welcomed by students and teachers of mathematics.

V.

The Correspondence of Sir Isaac Newton.
Edited by H. W. Turnbull, F.R.S. Vol. I
(1661-75): Pp. xxxvii + 467; Vol. II (1676-87): Pp. xii + 551. Price 147 sh. each
(Cambridge University Press, 200, Euston Road, London, N.W. 1), 1959/60.

A comprehensive edition of Newton's scientific correspondence is clearly most desirable, and no scientific body is more competent to undertake this task than the Royal Society of London. The magnitude of the work and the difficulties involved in the undertaking can easily be guessed from the fact that although the Royal Society has been engaged in this task for the past nearly three decades it was only in 1959 that the first volume could be brought out. The second volume has been published in 1960, and it is expected that the remaining volumes of the seven that will constitute the complete series will be published in the course of the next two years. Prof. Turnbull who was invited by the Council of the Royal Society in 1947 to undertake the editorship of the series has done an excellent job and placed the scientific world in general, and the scholars of the history of science in particular, under a deep debt of gratitude.

The volumes are to comprise all scientific letters of Newton and letters written to him and such other letters and documents as are necessary to clarify the correspondence. They have been arranged in chronological order, and wherever the texts are in Latin, the translations in English are also given.

In the first volume Prof. Andrade has written a scholarly introduction. This volume contains 156 letters covering the period 1661-75. Most of these letters, as also those in the second volume, were addressed to Oldenburg who as Secretary of the Royal Society and as editor of the *Philosophical Transactions* acted as medium for the scientific correspondence between Newton and other men of science. The first volume includes Newton's description of his telescope, the discovery of the composite nature of sunlight and the famous *experimentum crucis*, his letters dealing with Hooke's criticism of his views on refraction and colours, letters on fluxions and quadratures, and some on celestial mechanics.

The second volume covers the period 1676-87, and contains 162 letters out of which as many as 66 have not been previously published. A good many letters in this volume are concerned with the long drawn out correspondence between Lucas and Newton on Newton's new theory of light and colours. Another important content of this volume is the correspondence on the infinite series between Newton and Leibniz and Tschrnhaus. It includes the two letters: (i) *Epistola Prior*, and (ii) *Epistola Posterior*, known as "a veritable Newtonian treasury", and of which two pages of the original in Latin in Newton's handwriting appear as photoplates.

There is an interesting letter (232) which contains Newton's subtle reply to one Maddock (probably an unrecognized precursor of Sir Willian Herschel who was the first to investigate the invisible part of the spectrum), to the latter's thesis on "rays of darkness" and the query whether these rays will be refracted according to the law which governs rays of light. There are also letters relating to the great comet of 1680, letters on Boyle's discoveries, and even some on cider apples and methods of improving their quality.

These letters, besides their great scientific value, throw light on Newton's character and

on his relations with the contemporary men of science. There is no doubt that these volumes that have been produced in excellent print, paper and binding, should be in the possession of all scientific libraries and institutions.

S. P.

Homology Theory—An Introduction to Algebraic Topology. By P. J. Hilton and S. Wylie. (Cambridge University Press, London, N.W. 1), 1960. Price 75 sh.

In the general introduction to this rather voluminous treatise the authors confess with admirable candour that some of their friends have told them "that this is not the time to write a book on Homology Theory, at any rate not a book of this kind". The reviewer shares to a considerable extent this opinion, particularly in so far as "a book of this kind" is concerned. The reason is that Algebraic Topology is one of the domains which, at present, are continually and rapidly expanding. It follows that any text whose ambition is not restricted to a treatment as simple, concise and selective as possible may hardly deserve to be called an Introduction. The reviewer feels that the mimeographed notes of H. Cartan (Harvard, 1949) as well as some of the seminars mentioned in the bibliography constitute for the time being the best introduction possible, not going beyond a reasonable, minimum of notions and propositions around which a research student may easily organize his knowledge of the more advanced portions.

The first part of the book under review is devoted to the theories of homology, cohomology in the particular case of simplicial complexes. Infinite complexes are not excluded. Such theories call for a certain amount of what is now called Homological Algebra and the authors provide the reader with a systematic account of it in which, however, digressions and refinements might have been avoided: they will prove a hurdle to students not previously acquainted with Algebraic Topology, a category of persons for whom this book has been primarily written. The reviewer is also of opinion that the terminology and the notations of the authors are rather unfortunate. There is nowadays an almost universally accepted convention about saying cohomology and not contrahomology, about writing $\text{Hom}(A, B)$, $\text{Tor}(A, B)$ and $\text{Ext}(A, B)$ instead of $A \uparrow B$, A^*B , $A+B$. Students obliged to read extensively books and memoirs will find it unpleasant to have to remember a multiplity of terms and symbols.

The second part of the book deals with a much more advanced kind of Algebraic Topology. It is concerned with the theories of Singular Homology and of the Čech cohomology. It deals also with homotopy groups and the theory of obstruction cocycles. The chapters devoted to these theories are among the most interesting of the text. A last chapter treats of Spectral Homology and Spectral Cohomology.

It is surprising that the authors have not found it convenient to give a better and more complete account of the theory of differential forms. It has played, and is still playing, a very important part in Algebraic Topology along with its generalisation by Alexander. The de Rham theorem and the proof of it given by H. Cartan in his Seminar of 1948-49 should certainly occupy a place of honour in an Introduction.

If this Introduction is not, in the opinion of the reviewer, quite suited to the needs of a novice in the subject, it should however prove useful to research students having already studied the fundamentals of it. This because neither H. Cartan's notes, nor the Seminars by him and his collaborators, contain any exercises. Even the Foundations of Algebraic Topology by S. Eilenberg and N. Steenrod do not propose so many problems as the book under review (in particular they do not deal with homotopy). The problems found in great abundance in this Introduction, along with a certain number of developments which tend to make the text hard reading, will undoubtedly be very much appreciated by all those who want to become intimately acquainted with Algebraic Topology and to acquire a sufficient grasp of it to contribute to its further growth.

The reviewer was astonished not to find in the bibliography any mention of the pioneer and fundamental work of J. Leray, one to whom modern Algebraic Topology owes so much.

C. RACINE.

Infra-Red Methods, Principles and Applications. By G. K. T. Conn and D. G. Avery. (Academic Press, Inc., New York and London), 1960. Pp. viii + 203. Price \$ 6.80.

In spite of many books on the subject of the infra-red, the reviewer believes the present publication satisfies a real need felt by all those interested in a simple yet complete survey of practical techniques of the field. A selection of some of the main chapter headings will by itself serve to substantiate this statement: Sources of Radiation, Optical Materials, Detec-

tors, Amplifiers, Dispersive Systems, Instruments for Gas Analysis and Plant Control, Radiation Pyrometry.

S. P.

**Addison-Wesley Series in Physics—
Reading (Massachusetts, U.S.A.)**

Introduction to Mechanics, Matter and Waves.

By U. Ingard and W. L. Kraushaar. 1960.
Pp. xv + 672. Price \$ 7.00.

The book *Introduction to Mechanics, Matter and Waves* has been written as a text-book for the first year of a two-year course in general physics in American Universities. The plan of the book has been arranged to fit in with allied courses in mathematics which the student is expected to be studying concurrently. Thus fundamental ideas about motion, collisions, inertial mass and momentum are dealt with first, and the concept of force, as the rate of momentum transfer from one body to another during an interaction, is taken up later, by which time the student would have learnt enough in the calculus course to follow differentiation. The conservation laws of mass, momentum, energy and angular momentum have been dealt with in the clearest way possible. The five chapters on Examples of Forces and Motion are particularly instructive and deal with such diverse topics as square-well oscillator, two body oscillator, molecular vibrations, orbits in gravitational force fields, Rutherford scattering, precession gyroscope, etc. The chapters on heat and thermodynamics, mechanics of fluids, and wave motion have been dealt with in an easily understandable manner. The book throughout appeals to the deductive reasoning and intelligence of the student.

Foundations of Electromagnetic Theory. By J. R. Reitz and F. J. Milford, 1960. Pp. xi + 387. Price \$ 6.50.

The book is fundamentally of a mathematical nature and is intended for those who have a well-grounded knowledge of classical electricity and magnetism together with a good background in mathematics. The treatment is by vector methods. With the rapid progress that atomic physics has reached and the new concepts in the physics of the solid state, advanced students of electricity and magnetism will naturally approach the subject from the basic atomic constitution of matter and the electric and magnetic properties associated with them. This aspect has been kept in the forefront by the authors in writing this text-book and developing the various topics in a connected manner. The

chapters on microscopic theory of dielectrics, and of magnetic properties of matter and the one on the physics of plasmas are particularly interesting from this point of view.

This book can be recommended as a good supplementary text-book to the Graduate and Honours students of Indian universities.

Principles of Electricity and Magnetism. By E. M. Pugh and E. W. Pugh, 1960. Pp. xi + 430. Price \$ 6.50.

This is an advanced text-book on electricity and magnetism suitable for an Honours course in Physics. A good background knowledge of mathematics including vector analysis is expected of the student who will be using this text-book. However, a brief but self-contained exposition of basic vector analysis forms a separate chapter. Similarly a chapter is devoted to the fundamental principles of mathematics required for the general solution of electrostatic problems. The first six chapters of the book are devoted to static electricity and steady state current phenomena. The remaining five chapters are devoted to electromagnetic induction, magnetic properties of materials, alternating currents, and electromagnetic radiation. Each chapter ends with a number of problems, many of which are more in the nature of supplement to the textual matter than mere applications of it.

An Introduction to Electronic Theory of Organic Compounds. By H. L. Heys. (George G. Harrap and Co., Ltd., London ; Oxford University Press, Madras-2), 1960. Pp. 236. Price 16 sh.

As the title indicates, this book is an introduction to theoretical organic chemistry. It is intended to act as a bridge between the study of theoretical organic chemistry at the elementary and advanced levels. Mr. Heys has tried to present all the highlights of modern concepts and theories in simple language. Unfortunately, he has omitted several very important subjects. A few such bad omissions are, Hammett equation, acidity functions, recent work on steric effects (particularly the contribution by Brown and co-workers), neighbouring group participation (the contribution by Winstein and co-workers), internal rotation, conformation analysis, etc. In some places, the literature references cited are not representative. In trying to use simple language, inaccurate statements have been made occasionally. The author has mentioned diffraction and spectroscopic methods as structural tools. It would have been much better if these

structural methods had been discussed in slightly greater detail. Ultra-violet and visible spectroscopy has not been given any importance in the book. It is the opinion of the reviewer that any course in theoretical organic chemistry should necessarily include a sufficiently detailed discussion of the structural applications of infra-red and electron spectroscopy.

The book may still be used as an elementary introduction to theoretical organic chemistry.

C. N. R. RAO.

Handbook of Textile Testing and Quality Control. By Elliot B. Grover and D. S. Hamby. (Textile Book Publishers, Inc., a Division of Interscience Publishers, Inc.), 1960. Pp. 614. Price \$ 17.50.

The *Handbook of Textile Testing and Quality Control* by E. B. Grover and D. S. Hamby fills a void in the existing Textile Literature. It gives authoritative procedures of testing methods for determining the various attributes of the fibre and yarn, especially in regard to cotton and synthetic fibres and the yarns spun on the cotton system.

The lay-out of the book follows a logical pattern. The first chapter deals with the concept of quality control. It is followed by eight chapters on statistical methods which are essential for understanding the correct significance of quality control. The other chapters mostly deal with the details of the various testing methods for determining the properties of the fibres, yarn and fabric.

The description of each test procedure also follows a set pattern. After dealing with the manner of selecting the sample for test and handling the material, it gives the mode of operation of the instrument or machine for determining the particular property by avoiding or minimising sources of error, the method of calculation of the result and its interpretation. The testing procedures are in conformity with the accepted standards and are laid out in clear language. Not only does this help a novice to understand and follow the correct procedure for testing, but also it aids the experienced workers to follow uniform practices, so that reproducible results could be obtained, as far as possible.

Having dealt with the various fibre properties and the yarn strength, the effect of staple length on the yarn strength has been considered. It would have been more complete, if the relative importance of other properties had also been considered giving different regression equations for different groups of cottons.

Excellent as the book is, it appears to be confined, more or less, to the procedures followed in U.S.A. One cannot help feeling that the value of the book would have been further enhanced, if the authors' horizon had extended to the other parts of the world.

R. L. N. IYENGAR.

Toxicology—Mechanisms and Analytical Methods, Vol. I. Edited by C. P. Stewart and A. Stolman. (Academic Press, New York and London; India: Asia Publishing House, Bombay-1), 1960. Pp. 774. Price \$ 22.

The detection of poison in the body fluids, stomach wash and excreta during life and in tissues of the body after death is of paramount importance if poisoning has to be proved before a Court of Law. The incidence of poisoning both acute and chronic is constantly increasing as new chemicals are placed on the market and are used in homes and industry. The use of modern pesticides like Parathion, Endrine, etc., have resulted in cases of accidental poisoning. There are also many poisonous plants which are easily available in rural areas. In addition, there are many drugs which may produce side reactions of varying severity. There are, therefore, hundreds of substances to which one may be exposed giving rise to poisoning.

The isolation, characterisation, detection and estimation of such a wide range of substances from body fluids and tissues calls for great ingenuity on the part of the analyst. The classical methods hitherto followed in Forensic Science Laboratories have been found to be inadequate. Modern instrumental methods of analysis have necessarily to be applied. It is frequently necessary to isolate the poisonous principle in a pure form before instrumental methods can be employed. Many advances made in the field of chemical analysis are widely scattered in books and journals. The book under review has placed in the hands of the analyst wealth of information on all the modern methods in one volume.

The book which consists of 18 chapters is the work of 15 collaborators. Each chapter is written by a recognised authority in the special field of knowledge which he reviews and evaluates. At the end of each chapter there is a good bibliography.

In Part I, consisting of 6 chapters, the editing authors have dealt with the absorption, distribution and excretion of poisons and their metabolites. In Part II, the modern analytical techniques which are available for the Toxicologists along with the discussion of the principles on which they are based have been

given. Almost all modern methods of analysis such as Chromatography, both column and paper, use of Ion-Exchange resins, paper electrophoresis, emission and absorption spectra, Ultraviolet Spectrophotometry, Infra-red Spectroscopy, X-ray diffraction analysis, Polarography, Optical Crystallographic methods, Countercurrent distribution, Micro-diffusion analysis and Dye methods have been described with sufficient examples.

The book is an essential acquisition not only for all Forensic Science Laboratories where criminal human and cattle poisoning is investigated, but also to clinical chemists and bio-chemists, who may be required to assist the Pharmacologists in the evaluation of new drugs which may be potential poisons.

N. K. IYENGAR.

Petrology for Students. By Alfred Harker. Revised by C. E. Tilley, S. R. Nockolds and M. Black. (Cambridge University Press, London, N.W. 1), 1960. Pp. 283. Price 15 sh.

This book by Alfred Harker was first published by the Cambridge University Press, in 1895 and since then it has been a popular guide to all students of Microscopic Petrology. Its popularity amongst the students is indicated by the number of reprints it has gone through. This Edition has been fully revised by the three authors.

The book has been divided into five chapters. The first three chapters have been devoted to igneous rocks. The fourth chapter to sedimentary rocks and the last chapter to Metamorphic rocks. Practically all the groups of rocks have been described. A large number of Microphotographs to illustrate type rocks from different localities have been incorporated.

In the introductory chapter of this book, important optical characters have been described to enable the students to pick up the technique of rock identification easily.

The book is priced at 15 sh. and this standard publication on microscopic petrology is indispensable for all students preparing for the University Examination.

M. R. S.

Advances in Documentation and Library Science (Vol. III, Part 1)—Information Retrieval and Machine Translation. Edited by J. H. Shera and Allen Kent. (Interscience Publishers Inc., New York), 1960. Pp. xv + 686. Price \$ 23.00.

This is the first of the two parts of the papers and the proceedings of the International Conference on Standards on a Common Language

for Machine Searching and Translation. It was sponsored by the Western Reserve University and the Rand Development Corporation and held in Cleveland (Ohio, U.S.A.) from 6 to 12 September 1959. The volume includes 21 papers. Thirteen of them are from U.S.A., two from India, two from U.S.S.R., and one each from France, Germany, Holland, and Japan.

The first paper by Kent occupies a third of the volume. It gives a review of the projects in different countries on machinery for search and translation. This includes no project from India.

One of India's papers is on *Classifying, indexing, coding* by S. R. Ranganathan. It traces the different stages in the development of facet analysis in association with Colon Classification. It lays bare the progressive overcoming of rigidity in the idea, verbal, and notational planes until the postulational approach is reached. It sets forth the problems for the designers of search-machinery as viewed by a classificationist. The second paper from India is on *Faceted classification as an approach to machine coding* by S. Parthasarathy, Head of the Insdoc. It tabulates the difference in the quality of the notation needed for classification and machine-coding respectively. It makes out that the best result could be got by the successive use of subject heading by Chain Procedure, Class Number, and Code Number.

The technique of facet analysis, invented in India, permeates many of the other papers. The volume ends with a 30-page summary of the discussions on the papers. The discussions focus on the seeking for the standard qualities to be usefully possessed by any classificatory or machine language.

The Conference was partly a result on the Congressional Sub-Committee on Reorganisation (of the Committee on Government Operations). The Conference led to the formation of an International Continuation Committee. India has been assigned a place on it.

S. R. RANGANATHAN.

Cotton in India—A Monograph, Vol. III. By C. Nanjundayya, R. L. N. Iyengar, W. R. Natu, M. B. Ghatge, K. S. Murti, C. B. Parikh, B. L. Sethi and D. N. Mahta. (Indian Central Cotton Committee, 14, Nicol Road, P.B. No. 1002, Bombay-1), 1960. Pp. vii + 295. Price Rs. 30.

The present volume has six chapters dealing respectively with Technology, Ginning and Pressing, Marketing, Consumption of Cotton-seed, Consumption of Cotton lint, Legislative

measures and Exports and Imports. Each of the chapters has been handled by persons who with their long experience can speak with authority on their respective subjects.

The chapter on Technology gives a good account of the development and characteristics of the cotton fibre and methods of estimating quality of the fibre from the yarn spun from it. Nearly twenty pages of this chapter deal with the application of statistics which should certainly be considered out of place in this monograph as statistical principles are the same in whatever field of investigation they may be applied to.

The account on ginning and pressing describes, starting from the primitive methods the development of the various types of machinery now in use. The cotton ginning industry is almost parallel to rice milling industry of the country capable of considerable improvement and indications are given of the scope for such improvements. We wish the terms 'cotton' and 'lint' are more discriminately used in this chapter.

The chapter on consumption of cotton-seed brings together all available information on the structure of the seed, the extraction of different parts, their composition and uses. The different methods of oil extraction from the seed, the uses to which the cake and the oil are put to and the general position of the cotton seed oil industry in the country are described.

The various legislative measures that have had to be enacted to prevent malpractices in trade and to maintain purity of improved varieties grown in particular areas are discussed in the last chapter which also includes measures taken to prevent spread of particular insect pests. Due however, to the laxity in the enforcement of the Acts, the malpractices of trade have not been fully eliminated though they have been somewhat minimized.

The volume closes with a short account on 'Exports and Imports of Cotton'. The book contains valuable information and could be recommended as a useful reference to all interested in the various aspects of cotton industry in the country.

K. R.

Proceedings of the Centenary and Bicentenary Congress of Biology, Singapore, 1958. Edited by R. D. Purchon. (University of Malaya Press, Singapore), 1960. Price \$ 13.50 net.

The University of Malaya commemorated in 1958 the works of Darwin, Wallace and Linnaeus and brief reviews of the proceedings of the Congress have already appeared in several

journals. The papers presented at the Congress have now been brought out as a volume. It is a fitting memorial to Wallace who arrived at conclusions essentially similar to those of Darwin on Evolution while working in Malaya. The papers are interesting because they deal with tropical life which present problems more complex than those of temperate and arctic regions.

M. K. SUBRAMANIAM.

CORRECTION

The Price of the book "Mandl : *Introduction to Quantum Field Theory*," reviewed on p. 76 (February 1961) should read as 6.00 U.S. Dollars and Not 16.00 Dollars.

Books Received

Organic Electronic Spectral Data (Vol. I, 1946-52), (Vol. II, 1953-55). Edited by M. J. Kamlet and Herbert E. Ungnade. (Interscience Publishers, New York). Pp. xiv + 1208, Pp. x + 919. Price \$ 28.50, \$ 17.50.

Russia's Rocket and Missiles. By A. Parry. (Macmillan & Co., Ltd., St. Martin's Street, London, W.C. 2), 1960. Pp. 382. Price 25 sh.

Indian Woods, Vol. I. By K. A. Chowdhury and S. S. Ghosh. (Manager of Publications, New Delhi), 1958. Pp. liii + 304. Price Rs. 25.50.

Fatty Acids—Their Chemistry, Properties, Production and Uses, Part I. Edited by K. S. Markley. (Interscience Publishers, New York), 1960. Pp. ix + 714. Price \$ 22.50.

Elements of the Theory of Markov Processes and their Applications. By A. T. Bharucha-reid. (McGraw Hill Book Co., New York), 1960. Pp. xi + 468. Price \$ 11.50.

Preparative Methods of Polymer Chemistry. By W. Sorenson and Tod W. Campbell. (Interscience Publishers, New York), 1961. Pp. viii + 337. Price \$ 10.50.

Introduction to the Statistical Dynamics of Automatic Control Systems. By V. V. Solodovnikov. (Dover Publications, New York-14), 1960. Pp. xx + 307. Price \$ 2.25.

Biochemical Society Symposium No. 20—The Biochemistry of Mucopolysaccharides of Connective Tissue. (Cambridge University Press, London, N.W. 1), 1961. Pp. 125. Price 15 sh.

British Medical Bulletin (Vol. 17, No. 1, January 1961)—*Hypothermia and the Effects of Cold.* (The Medical Department, The British Council, 65, Davies Street, London, W. 1). Pp. 78. Price 20 sh.

No. 5
May 1961 |

SCIENCE NOTES AND NEWS

Polyembryony in Mulberry

Shri B. C. Das, Central Sericultural Research Station, Berhampore, West Bengal, writes:

The phenomenon of polyembryony, although common in gymnosperms, is only sporadic in the angiosperms. In the present case the author came across a case of polyembryony in mulberry in course of a germination experiment. Seeds were obtained from a cross between an indigenous mulberry *Morus indica* Linn. var. *laciniata* (Kapil) and a Chinese mulberry *M. alba* Linn. In order to study the percentage of germination of F_1 seeds, they were allowed to germinate in a petri dish in March, 1961, when one twin seedling with two plumules and two radicles was noted to emerge from a single seed (Fig. 1).



FIG. 1. A polyembryonous mulberry seedling with two plumules and two radicles.

This specimen has been preserved in the laboratory.

Effect of Gibberellic Acid on Beroeem

Messrs. J. S. Kanwar and S. L. Chopra of the Government Agricultural College, Ludhiana, write:

Pot experiments conducted during the years 1959-60 have shown that the yield of beroeem (*Trifolium alexandrinum*) can be nearly trebled by spray treatment with gibberellic acid (GA). The beroeem plants were grown in pots each pot containing 20 lb. of Ludhiana fine sandy loam soil. To each pot was added 2·5 gm. of superphosphate, which is equivalent to 100 lb. of P_2O_5 per acre. GA solution was sprayed on the plants before first cutting only. There were six treatments; in all the first five with 0·25, 0·50, 0·75, 1·00 and 1·50 mg. of GA per pot, and the sixth one with 1·50 mg. GA plus 1 mg. urea. There were four replicates of each treatment, and three cuttings of green fodder were taken to analyze the effect of treatment on yield.

The total yields of dry matter in the six treatments were respectively 28·0, 31·4, 101·5, 98·0, 110·5 and 75·0 gm. per pot, as against 40·8 gm. per pot of the control. The maximum yield of 110·5 gm. (control 40·8 gm.) was obtained with 1·50 mg. of GA. The yield on the first cutting alone showed a nearly five-fold increase with this concentration, namely 1·50 mg. of GA. These preliminary experiments clearly bring out the potentialities of the use of GA in increasing the yield of this useful fodder crop.

Control of Safeda Muskmelon Fruit Rot

Messrs. R. S. Mathur and S. C. Verma, Laboratory of Plant Pathology, U.P., Kanpur, write:

Near about Lucknow severe fruit rotting of Safeda muskmelons (*Cucumis melo*) is caused by a wound parasite *Pythium aphanidermatum* (Eds.) Fitz., the predisposing factor being skin injury to fruits and their contact with wet soil. In replicated field trials conducted at Kanpur and at Lucknow during 1958-60, the current practice of sowing by broadcast of seed and heavily irrigating the muskmelon beds where the fruits come in contact with wet soil, was changed and, further, the skin injury to the fruits was prevented by dusting the fruit-bearing vines weekly with Pyroduct. When sowing was done by dibbling and the roots were so irrigated with water in channels that the adjacent plots were kept dry for the fruit-bearing vines to spread, fruit rotting was negligible as compared to an average of 25% fruit rotting in the check plots.

The British Association for the Advancement of Science

The 123rd Annual Meeting of the British Association for the Advancement of Science will be held this year at Norwich, England, from August 30 to September 6. The BAAS was founded in 1831 to promote general interest in science and its applications. One of its chief activities is the Annual Meeting, which is attended by eminent scientists as well as young students. It has 14 sections covering the whole range of pure and applied science.

This year's meeting will be under the presidency of Sir Wilfrid Le Gros Clark, Professor of Anatomy at Oxford University. Sir Wilfrid has worked on the regeneration of the central nervous system, with experimental studies on the growth and regeneration of the muscular system. At the same time, his wide knowledge of fossils has been extensively recognized.

A wide variety of topics of fundamental and current interest will be discussed at the meeting, and will include detection of underground nuclear explosions, new particles, new sources of power, the living cell, and food processing and health. The Eidophor process, which makes possible large-screen projection of colour television, will be demonstrated. In addition, this system will be used to transmit the inaugural meeting in full colour to an overflow audience.

Institution of Chemists (India)—Associateship Examination, 1962

The Twelfth Associateship Examination of the Institution of Chemists (India) will be held in November, 1962. The last date for registration is 30th November 1961. The Examination in Group A (Analytical Chemistry) is divided into the following eleven Sections and each candidate will be examined in two of them according to his choice as approved by the Council, in addition to the General Chemistry including Organic, Inorganic, Physical and Applied Analytical Chemistry : (1) Analysis of Minerals, Silicates, Ores and Alloys ; (2) Analysis of Drugs and Pharmaceuticals ; (3) Analysis of Foods ; (4) Analysis of Water and Sewage ; (5) Biochemical Analysis ; (6) Analysis of Oils, Fats and Soaps ; (7) Fuel and Gas Analysis ; (8) Analysis of Soils and Fertilisers ; (9) Analysis connected with Forensic Chemistry ; (10) Analysis connected with Leather Chemistry, and (11) Analysis connected with Textile Chemistry. The Examination is recognised by the Government of India as equivalent to M.Sc.,

in Chemistry for purposes of recruitment of Chemist.

Further enquiries may be made to the Honorary Secretaries, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

Symposium on Low-Temperature Carbonisation of Non-Caking Coals

A symposium on 'Low-Temperature carbonisation of non-caking coals and briquetting of coal fines' is being organised at the Regional Research Laboratory (Council of Scientific and Industrial Research), Hyderabad-9, on November 20, 21 and 22, 1961.

Those who wish to participate in the symposium are requested to send before August 15, a brief abstract of the paper to be presented at the meeting. This should be followed by the detailed paper by September 15, 1961. Pre-prints of research and technical papers will be supplied to the participants by October 15, 1961.

All communications and enquiries in connection with the symposium may be addressed to the Director, Regional Research Laboratory, Hyderabad-9 (A.P.).

Journal of Theoretical Biology

Academic Press, London and New York Publishers, have just released the first issue of the *Journal of Theoretical Biology* of which Professor J. F. Danielli, King's College, London, is Chief Editor. This new international periodical will serve as a central medium for the publication of original papers in theoretical biology. The following contributions in Volume 1, Number 1, Pp. 1-106, January 1961, will indicate the scope of the journal and its utility to persons concerned. Possible functions of chains of catalysts, by R. J. P. Williams ; Permeation through a spherical membrane, by G. G. Hall ; Quanta and the concept of organismic law, by Walter M. Elsasser ; Methods for measuring and correcting the absorption spectrum of scattering suspensions, by J. Amesz, L. N. M. Duysens, and D. C. Brandt ; The supra- and submolecular in Biology, by Albert Szent-Gyorgyi ; An analysis of the idea of "Resources" in animal ecology, by H. G. Andrewartha and T. O. Browning ; Reductions and oxidations in mammalian biosyntheses, by John M. Lowenstein ; Surface extension as the mechanism of cellular movement and cell division, by L. G. E. Bell.

The rate for institutional subscribers to Volume 1, is 121 s. 6 d. or \$ 17.00. Scientists certifying issues will be for their personal use

only are offered a special subscription price of 86 s., or \$ 12.00 for Volume 1.

Indian Journal of Microbiology

The Association of Microbiologists of India, founded in 1938, have undertaken the publication of a new journal *Indian Journal of Microbiology* which will be a quarterly coming out on the last day of March, June, September and December. The object of the Journal is to publish the results of microbiological research in India in all the divergent and specialised directions it is taking.

The contents (noted below) of the first issue of the journal (Vol. 1, No. 1, Pp. 1-64) will indicate the general scope of the Journal although they are by no means an index of the large amount of work that is being carried out in this field of study in the country. Amide Hydrolysis by *S. typhosa*; Nucleolytic Enzymes of *S. typhosa*; Rhizosphere Bacteria of Wheat and Berseem; *Escherichia coli* Serotypes; Influence of Soil Solution on Nitrogen Fixation; Antivitamins and Excretion of Amino-acids by *V. cholerae*; Turnip Crinkle Virus in India; Potassium Nutrition and Multiplication of Tobacco Mosaic Virus; Heat Resistance of *B. subtilis* Spores; Concentration Methods for Tubercle Bacilli; *Candida* infection in Leucorrhoea.

The annual subscription of the Journal for non-members is Rs. 15 (Inland) and Rs. 20 (Overseas), Address: P-27, Prinsep Street, Calcutta-13.

Biological Effects of Radiation

New research findings on the biological effects of atomic radiation were reported at a study group meeting organized by the International Atomic Energy Agency in Vienna last month.

One of the subjects discussed was the mechanism by which radiation damages the cell. This may well be described as the fundamental problem in radiobiological research. While in the past the radiation damage itself has been studied in great detail, the exact process by which it is caused is still not clear. One of the theories discussed at length at the Vienna meeting was that radiation leads to the release of enzymes within the cell and this in turn may cause destructive chemical changes in the cell structure. Another theory discussed at the meeting dealt with modification of the permeability of cell membranes, which might be connected with the enzyme release hypothesis.

The meeting also discussed how the findings of radiobiological research could be used in

devising new methods of food preservation. It was disclosed that experiments on the sterilization of food by the combined use of heat and low-level radiation appeared particularly promising; this would obviate the necessity of using very large radiation doses that might have undesirable effects on the food.

In the field of drugs, there was a discussion on preliminary results of experiments to produce polio vaccine by using a combination of radiation and chemical agents for the inactivation of the virus. The possibility of using radiation for virus research was also mentioned; a new technique suggested at the meeting is to irradiate the cells of experimental animals in order to make them accept human viruses so that the growth, behaviour and control of the viruses can be effectively studied.—(I.A.E.A. News.)

Polyvinyl Chloride Coating Makes Glass Bottles Safer

A process which aims at lessening the effect of possible explosions of glass bottles containing volatile liquids has been suggested by Rene Droessaert of France. The process consists in coating the outside of the bottles with a layer of polyvinyl chloride (PVC). As PVC cannot be applied direct to the glass, the bottle is dipped in a solution of vinyl chloride and vinyl acetate, dried in air for a minute and then baked at a temperature of 180° C. for three minutes. The final layer of PVC is applied and baked for thirty minutes at 155° C. If this temperature is raised to 325° C. the PVC becomes transparent.—(New Scientist.)

The Ecology of Acanthariois (Radiolaria) in Relation to the Circulation of Sr in the Sea

It has been known for a long time that a class of Radiolaria, the Acanthariois, possess a mineral skeleton which is not calcareous or siliceous, but is formed by celestite (SrSO_4).

A way of investigating the nature of the sticles was to investigate the isolated material by X-ray crystallography. Such a technique was used by Professor L. Cavalea (University of Parma). The results have shown that the sticle is a rhombic monocrystal of SrSO_4 . Chemical analysis on 500 individuals have further yielded a value of Sr of 0.1-0.3 for every individual.

The fact that the presence of Acanthariois in the plankton varies with the season and their rapid and considerable vertical migration, suggest that these zooplankton components are very useful for studying the problem of a monitoring technique of Sr 90.

The aim of the research, which will be carried out at the Department of Zoology, University of Parma, is to ascertain the role of the Acantharius in the capture and the distribution of Sr in the food chain both of natural isotopes present in the sea and of the radioactive Sr present in fall-out.—(IAEA-Research Contract.)

Removing Sulphur Fumes from Chemical Plants

Hydrogen sulphide, found in the waste gases emitted from chemical plants, may be oxidized and converted into sulphur, using what has been claimed by the Osaka Gas Company in Japan, to be a new, simple and economic process.

The gas, mixed with air at room temperature, is brought into intimate contact with an organic catalytic solution, and the sulphur so formed is removed either by filtration or by skimming off the sludge that floats on the surface of the liquid. The catalyst can be almost any nitrated phenol; the example quoted by the Company is picric acid.

The process could have considerable advantages if it were linked with one of the well-known processes for extracting hydrogen sulphide from coal or producer gas and subsequently discharging it into the atmosphere.—(New Scientist.)

Electrons in the Primary Cosmic Radiation

Although the question of the presence of electrons in the primary cosmic radiation has frequently been discussed in literature attempts to identify such a component have so far been negative. P. Meyer and R. Vogt of the Enrico Fermi Institute for Nuclear Studies have reported (*Phys. Rev. Letters*, 1961, 6, 193) an experiment which leads to the conclusion that there exists a flux of electrons which enters the top of the atmosphere.

Three balloon flights for cosmic ray investigation at high altitudes were carried out in August-September 1960, from Fort Churchill Manitoba, which has a calculated geomagnetic cut-off rigidity for vertically incident particles of about 100 Mv. Data were obtained in each flight during the ascent and for approximately 10 hours under 3 to 5 g./cm.² of residual atmosphere.

Cosmic ray "events" were recorded by the conventional detector system consisting of NaI end counters with lead absorbers and inter-

mediate range counters. Analyses of the range spectrum of the "events" have revealed that all of them could not have been produced by high energy protons and mesons only, but that a substantial fraction of the "events" was to be attributed to primary electrons. Further, results of analysis have also shown that primary electrons above the calculated geomagnetic cut off of 100 Mv. were present in the incoming radiation, and these could only be of interplanetary or of galactic origin. It should also be noted that the flights were conducted at a time of normal solar activity.

Intensity Sensitivity of the Human Eye

At the Fifth Annual Conference of the British Society for the Philosophy of Science, held in Bristol in September 1960, Dr. M. H. Pirenne (Oxford) presented the results of his experiments on the threshold intensity of light visible to the human eye. According to these experiments there was not a sharp transition from visibility to invisibility as the energy of a light-flash was decreased, and threshold was defined by an arbitrary statistical measure in the range of critical intensities. The results showed that the human eye could detect flashes of about 100 quanta in the narrow band of blue-green wavelengths to which the periphery of the retina was most sensitive. Of these 100 quanta in the light-flash only about 10 reached the retina and were there distributed among about 500 rods.—(*Nature*, 1960, 188, 458.)

Mesta as a Border Crop on Sugarcane Plantation

It has been established by intensive field research that a crop of mesta (*Hibiscus cannabinus*) grown on the periphery and along the water channels of sugarcane field, can yield 4 to 5 mds. of fibre per acre.

The cultivation of mesta, which yields a fibre comparable to jute in many respects is a long established practice in India.

The cost of mesta production is generally low because it is hardy crop and it will be still lower if cultivated as a border crop on a sugarcane plantation. Upwards of 4 million acres are planted annually with sugarcane in India. The growing of mesta along with sugarcane on even a fraction of this vast area can lead to a large increase in the supply of fibre.—(Indian Central Jute Committee, Calcutta-1.)

291-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, Current Science, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00.

Foreign : Rs. 16-00 ; £ 1-4-0 • 4 00

MOLECULAR ELECTRONICS

DR. S. W. HERWALD

Westinghouse Electric Corporation

EFFORTS to elevate air and space craft to new plateaus of capability are continually made more difficult through a technical paradox. As we make these craft more sophisticated through the use of advanced electronic gear, the risk of failure among components and connections grows. And as we add this more complex electronic equipment it becomes more difficult to provide for its weight and size. The problems of improvement of reliability and reduction or weight and size of electronic equipment may be approached in several ways. But such techniques as better quality control on components and connections, and miniaturization, while exploiting modern technology, do not yield maximum reliability.

In the recent past, a substantial part of Westinghouse research and development effort has been focused on a new approach to both problems. It exploits a new concept in the design and function of electronic systems. In fact, it is a broader concept of electrical engineering which we call "molecular electronics" to indicate its dependence on phenomena occurring within or between domains of molecules in the solid state. In this programme a variety of molecular electronic "function blocks" are now being produced, three of which are shown in Fig. 1, as solid-state elements that achieve,

many, varied items of electronic hardware. Because of this, these elements are not intended as "components", as we think of transistors and tubes, but rather as "subsystems" since each of the function blocks has the ability to achieve an electronic result which is essential if all the subsystems in the entire system are to work together effectively. These function blocks perform such electronic operations as amplification, oscillation, telemetering, etc.

Because there are no internal connections or components, and the only external connections needed are those for coupling inputs and outputs to the complete system, it is possible to build subsystems whose risk or failure should be equal to or less than that of familiar solid-state devices and perhaps one-thousandth of that for a subsystem built of many parts for the same purpose. This ability of molecular electronics to reduce the number of components and connections required is illustrated by a comparison of three designs for a light telemetering subsystem, Fig. 2. When designed to use electronic tubes, this subsystem required 16 components and 18 soldered connections; when designed to use transistors, it required 14 components and 15 connections. In contrast a molecular electronic subsystem developed to achieve the same purpose needed but one component and two connections. Also, because their internal functions involve distances of the order of a few atomic spacings, these function blocks are almost microscopically small and virtually weightless. For example, weight of the light telemetry subsystems was reduced from about one ounce to one quarter of an ounce, the weight of the monolithic element to about seven-tenths of an ounce.

As the basis for these molecular electronic subsystems, we have a very substantial knowledge of solid state phenomena developed over the past thirty years. It is simple now to create materials having excessive positive or negative electrical charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification or amplification, as in diodes and transistors. Also, we can readily take advantage of the ability of radiation to cause charge paths to occur in a semiconductor material along which current will flow when the material is irradiated.

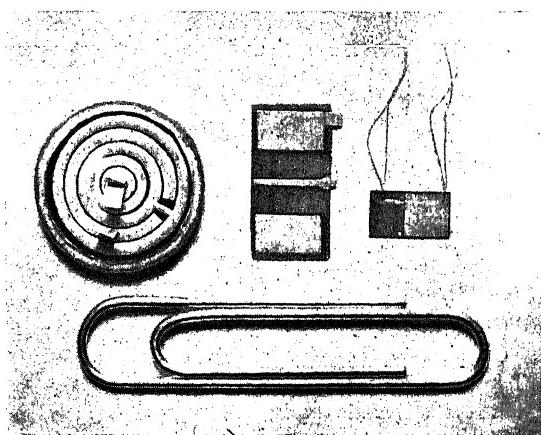


FIG. 1. Three of eight molecular electronic function blocks demonstrated as subsystems. Device bearing concentric arcs is an audio amplifier, at centre is a free running multivibrator, and at right, a two-stage video amplifier.

entirely within themselves, electronic results such as have been gained only by assembling

Effects of this general type are used in molecular electronic blocks by creating—usually in single crystals—a number of distinct operative domains. The domains border one another at

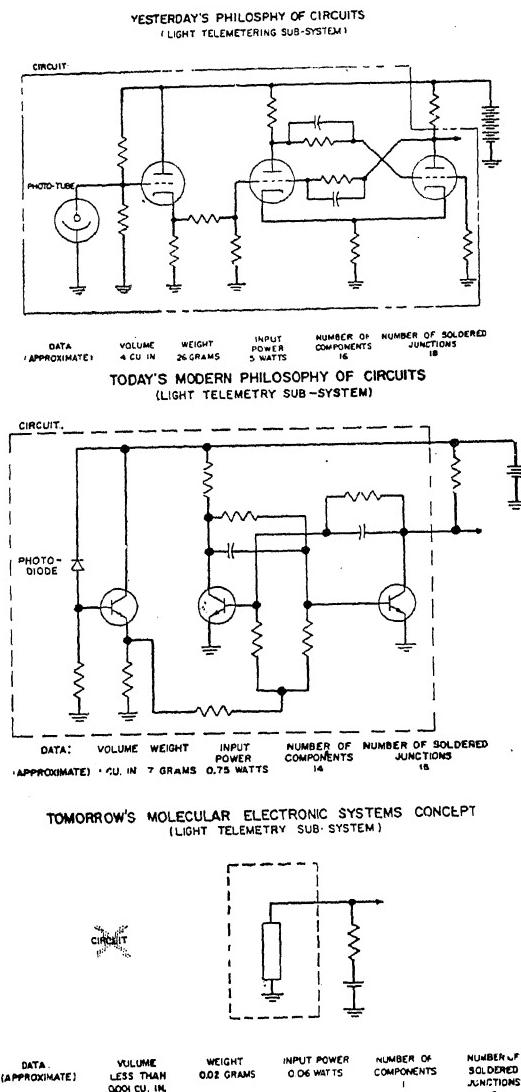


FIG. 2. Schematic drawing of light telemetry subsystems showing extent of circuitry required for systems using (1) electronic tubes, (2) transistors, and (3) molecular electronic element.

boundaries called interfaces where phenomena different from those occurring inside the molecular domains are initiated.

As a simple example in the element diagrammed in Fig. 3 we see that it is composed

of two domains which meet physically at one interface. One of these domains is composed of a resistive material selected and shaped to present a resistance R_1 to the passage of current; the other domain is also resistive, but is so planned that it has a resistance R_2 . At the interface, the interaction between domains causes a capacitive effect. Thus, in one tiny element we have a subsystem equivalent to a time-delay circuit.

Schematic Diagram of a Molecular Electronic Function Block for Time-Delay as Provided by R-C Circuit

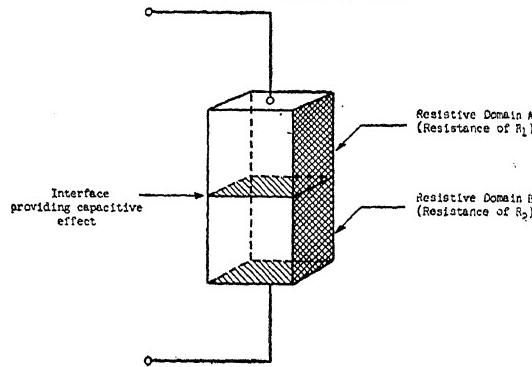


FIG. 3. Schematic drawing of function block of two resistive domains and one capacitive interface, whose total effect is that of an RC or time-delay circuit.

Another illustration of the uses of domains and interfaces is a function block designed as an ac-to-dc power supply for transistor circuits. It makes use of the Seebeck effect for the thermoelectric generation of electricity to convert 110-volt alternating current to 9-volt direct current power. In contrast, the conventional circuit, Fig. 4, requires five individual

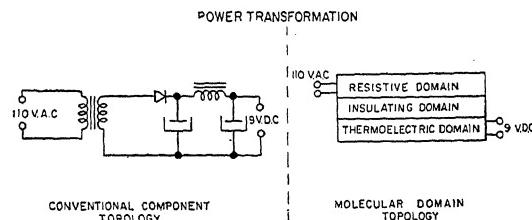


FIG. 4. Schematic drawing of a-c to d-c power supplies showing (1) molecular element with resistive, electrical-insulating, and thermoelectric domains and (2) conventional method using transformer, diode, and filter circuit.

components—a transformer, a diode, and the inductive and capacitive elements making up the LC filter circuit. To accomplish this same purpose with electronic methods, we have a

function block comprising three separate domains. When a-c power is applied to the resistive domain, the heat that is generated passes through the domain at the centre; this domain is an electrical but not a thermal insulator—and into the thermoelectric domain where the energy is converted into electrical energy by the Seebeck effect. By proper control over the materials used, we provide the 9-volt d-c output we desire. An interesting aspect of the power supply is that elimination of ripple as an undesirable variation in voltage is inherent since heat flows from the resistive domain to the thermoelectric domain at practically a constant rate.

As these two examples suggest, the concept of molecular electronics makes no use of the traditional circuit-and-component approach to electronics. Instead, the objective is to use our knowledge of the structure of matter to synthesise monolithic function blocks whose arrangement and composition permit each to serve as a substation to perform an electronic function in the control or transformation of energy.

To achieve function blocks with this capability, a number of effects and phenomena of the solid state are available. The only firm limitations on choice are that the effect must not react adversely on system reliability and must lend itself to consistent results when included in a function block. Methods typical of practice so far include: solid-state phenomena, such as the Seebeck generation, Peltier cooling, and Hall-effect multiplication; the use of PN semiconductor junctions arranged to produce a result which would otherwise require numerous individual components; and when necessary, fabrication of circuit elements within a function block. Although such phenomena will be most often used for the control of electrical signals, they will also be suitable when quantities like electromagnetic radiation, heat, and mechanical displacement are inputs or outputs.

The design of a subsystem begins with the designer's analysis of the requirements of the system, to establish the functions to be performed by the function block. After logic processes are determined and suitable physical effects settled upon, a topologist—a mathematician who works with shapes—determines the structure of the block by designing, on paper, the arrangements of domains and interfaces that is to control the flow of energy in the block. The block is then produced by the materials engineers who use germanium and silicon as the basic semiconductor materials.

In producing these blocks we do not assemble them from various tiny components. Rather, we start with a basic semiconductor wafer and produce the necessary domains and interfaces by techniques used in the production of conventional semiconductor devices, including diffusion, plating, electron beam machining, etching, cutting, radiation, alloying and photographic processes. Although the function block so produced can now perform its function, additional processing steps are required to encapsulate the block, protect it against shock and vibration, and make it stable under the conditions of temperature and radiation it will encounter.

One important illustration of the contributions made by materials scientists is the development of a method for the rapid production of semiconductor crystals in a form that requires no removal of material to make them into suitable wafers for use as transistors or as the basic elements of molecular electronic elements. This is the dendrite process in which germanium crystals in the form of ribbons about one-eighth of an inch wide and a few thousandths of an inch thick, are produced by drawing them from a molten mass.

The dendritic method is essentially a continuous process in which the germanium ribbon grows at the rate of 6 to 12 inches per minute and in the precise direction of crystal growth we require for application.

Now, although this dendritic method has immediate usefulness in molecular electronics today, we are confident that its greatest significance is its ability to bring about a number of new processes for producing fundamental blocks. We are now most interested in a recent modification which makes it possible and practical to carry out diffusion, plating, and evaporation processes directly on the crystal as it grows from the furnace melt. With this technique, we are able to create semiconductor devices ready for the attachment of leads. One of the first uses has been to grow transistors in the form of a long germanium crystal.

When the ribbon-like crystals are cut into segments, only simple processing is needed to produce transistors at a yield very near 100%. By this method we have produced lengths of ribbon along which small multiple-junction subsystems are distributed, Fig. 5. Since these ribbons can be easily processed to become a long series of tiny amplifiers, it is not at all facetious to say that this ribbon can be snipped into lengths to give us amplifiers of whatever gain we desire.

A more recent and extremely significant achievement resulting from our research is that we have now discovered how to grow multizoned

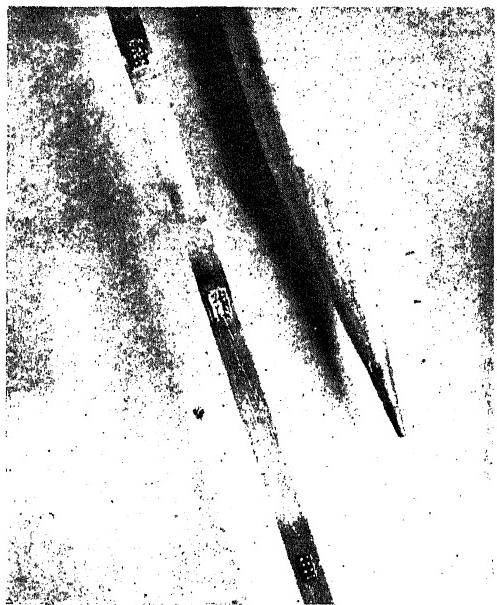


FIG. 5. Ribbon bearing multiple-junction systems on germanium crystal produced by dendrite process.

crystals as dendrites, directly from the furnace melt. We regard this development as a major

event in new technology of molecular electronics. It makes available to us basic building blocks having at least three layers of zones and two interfaces. Thus it will no longer be necessary to perform many operations to create multizone elements.

In considering the implications of this basic method for crystal growth, one most interesting possibility is that it will prove practical to combine our ability to grow multizoned crystals with our ability to perform operations on the crystal at the time it is growing in the furnace. Admittedly, to achieve near-automatic production of semiconductor devices and molecular electronic function blocks is a long-range objective, but it is probable that we will eventually be able to "grow" from a pool of molten semiconductor materials some items of electronic equipment that today are of the order of complexity of radio receivers and amplifiers.

Although there was a 20-year interval between the invention of the vacuum tube and its first significant application, and an 8-year interval between the development of the transistor and its first uses, it is almost certain that no such delay is likely for molecular electronics. It is very likely that in three to five years we will see the molecular electronic concept widely applied in air space electronic systems for such important applications as telemetering, fire control guidance, communications, etc.

OBITUARY

SIR K. S. KRISHNAN

WE deeply regret to record the death of Sir K. S. Krishnan, Director, National Physical Laboratory, New Delhi, on Wednesday, the 14th of June, 1961.

Krishnan was born on the 4th December, 1898. He graduated from the Madras Christian College and later migrated to the University College of Science at Calcutta where he studied for two years. Sir C. V. Raman chose Krishnan for a position as Research Assistant in his laboratory and sponsored his promotion to the various positions held by him in later years ; Reader in Physics at the Dacca University ; the Mahendra Lal Sircar Professor at Calcutta in 1933 and University Professor of Physics at Allahabad in 1942. Sir C. V. Raman also proposed him for the Fellowship of the Royal Society

to which body he was elected in 1940. Krishnan was appointed as the first Director of the National Physical Laboratory at New Delhi in 1947. This position he held till his death.

In his earlier years, Krishnan was closely associated with Sir C. V. Raman in his investigations. After the discovery by Sir C. V. Raman of the effect known by his name, Krishnan and later on, other workers also in the laboratory, assisted in following up the consequences of that discovery. At about the same time, systematic researches on magnecrystalline action were initiated by Sir C. V. Raman and were first carried on by Bhagavantam at Calcutta. These were subsequently continued by Krishnan at the Dacca University and formed the basis of his election to the Fellowship of the Royal Society.

PREVENTION OF FLOWERING IN SUGARCANE

R. R. PANJE AND T. RAJA RAO

Indian Institute of Sugarcane Research, Lucknow

FLOWERING in commercial sugarcane crops is undesirable; with floral initiation, vegetative growth of the apical meristem ceases; the leaf-crown dwindles into short-blades, thus diminishing its fodder value. Later, the top portion of the cane becomes pithy and, due to the loss of apical dominance, develops side shoots. Finally there is a gradual drop in sugar content. Non-flowered canes are therefore preferred both by the grower and the sugar manufacturer.

In varietal selection, the tendency to blossom is a negative attribute. However, there are some good commercial varieties, which flower somewhat freely; if the flowering of these varieties as crops can be prevented, these varieties may become more profitable or acceptable than they are now.

Since the switch-over of the apical meristem from the vegetative to the reproductive phase is caused by hormonal changes and these in turn are brought about by the perception of the photoperiodic stimulus by the plant, flowering can presumably be prevented by an appropriate interference with one or other of the links in the process of floral initiation; i.e., either (i) by avoiding or circumventing the stimulus itself, *viz.*, the photoperiod; (ii) by preventing the perception of the stimulus by the plant, or (iii) by the action of suitable chemicals on the pre-flowering metabolic changes. Studies of Cajlachjan (1936, 1945), Borthwick and Parker (1938) Withrow *et al.* (1943), Hamner and Naylor (1939), Greulach (1942) and others have clearly indicated that the green leaves are the organs of perception in this case. Since the use of chemicals and interference with the photoperiod are *prima facie* not likely to be commercially acceptable, efforts were made in our experiments in the direction of third alternative, namely, elimination of the perception mechanism through defoliation of plants.

It was found by periodically dissecting the leaf spindle that under Lucknow conditions, floral initiation takes place in early October in the majority of cases. It was presumed from this that the critical photoperiod, its perception by the plant and the connected metabolic changes in the plant would very likely occur in the 2 or 3 weeks preceding this date; accordingly, defoliation was done in different treatments in successive weeks from end-August to

early-October, employing two heavily-flowering varieties, Co. 1207 and Co. 1062. In the former, about 450 stalks were treated; in the latter about 850. Defoliation was effected by cutting off the blades at the dewlap.

TABLE I

Percentage of flowering and short-blade stalks at harvest

Defoliated on	Spindle cluster including the topmost dewlap blade removed		Spindle cluster and three leaves removed Co. 1207
	Co. 1062	Co. 1207	
August			
12 ..	55.3	..	..
27 ..	54.5	..	..
September			
2 ..	8.7	..	..
5 ..	..	26.7	..
8-9 ..	5.0	20.2	15.2
14-15 ..	1.7	4.3	2.6
20 ..	2.9	..	..
23 ..	..	8.8	0.9
26 ..	2.4	..	..
October			
2 ..	15.7	..	..
8 ..	46.6	..	..
Control ..	53.0	55.2	55.2

The results (Table I) indicate that defoliation from 14th to 26th September has almost entirely suppressed flowering; the treated stalks remained vegetative, and provided the normal full leaf-crowns at harvest.

Further the treatments show a clear gradient in the suppression effect, the percentage of flowering-cum-short-blade stalks to total number of stalks falling with the defoliations of successive weeks from end-August up to the 3rd and 4th weeks of September when the maximum suppression occurred; later defoliations were progressively ineffective. The third observation is that the critical defoliation date is the same for both the varieties.

Borthwick and Parker (1940), Gerhard (1940), Ullrich (1939), Naylor (1941), Moskov (1937) and others have inferred from their studies that young expanding leaves of plants are insensitive to the photoperiodic stimulus, while the sensitivity of the fully unfurled leaves depends on the age of the leaf, the youngest being the most sensitive and the oldest mature leaves being relatively insensitive. In our experiments on Co. 1207, two degrees of defoliation were tried: (i) removal of spindle cluster including the blade of the topmost dewlap and (ii) removal of spindle cluster and three more blades below it. The results (Table I) suggest that the

young expanding blades of the spindle cluster plus the blade of the topmost dewlap constitute the principal sensitive organ for the perception of photoperiodic stimulus; the sensitivity however extends to some extent to the next lower three or four leaves also. Apparently, there is a sensitivity gradient in the leaves; this is being investigated in further experiments.

The results indicate a clear possibility of keeping sugarcane crops in the vegetative condition by adopting a cultural practice which is obviously adoptable under Indian conditions, even though in Hawaii it has not been found practicable on a plantation scale.

-
1. Borthwick, H. A. and Parker, M. W., *Bot. Gaz.*, 1932, **100**, 245.
 2. — and —, *Ibid.*, 1940, **101**, 806.
 3. Cajalchjan, M. C., *Compt. Rend. (Dok) Acad. Sci., U.R.S.S.*, 1936, **4**, 79.
 4. —, *Ibid.*, 1945, **47**, 220.
 5. Gerhard, E., *J. Landw.*, 1940, **87**, 161.
 6. Greulach, V. A., *Bot. Gaz.*, 1942, **103**, 698.
 7. Hammer, K. C. and Naylor, A. W., *Ibid.*, 1939, **100**, 853.
 8. Moskov, B. S., *Bull. Appl. Bot. Gen. and Pl. Breed. Ser. A. Supplement*, 1937, No. 21, p. 145.
 9. Naylor, A. W., *Ber. D. Bot. Ges.*, 1941, **103**, 342.
 10. Ulrich, H., *Ibid.*, 1939, **57**, 40.
 11. Withrow, A. F., Withrow, R. B. and Biebel, J. P., *Plant Physiol.*, 1943, **18**, 294.

INTERNATIONAL CONTROL OF INVESTIGATIONS OF RARE METEORITES

IN recent years the study of meteorites has rapidly increased and, in the hands of investigators such as Urey, Anders, Wiik, Vinogradov and others, has thrown much light on the composition and origin of the solar system and of the planets. Last year, through the work of Mason on hydrous silicates in meteorites, interest has concentrated on the rarest form of meteorites, those which contain carbonaceous material. It follows from Mason's results, as well as from the earlier analyses of material by G. Mueller, that carbonaceous meteorites, unlike all other types, had never been subjected to high temperatures since their formation and that they might well contain samples of the raw materials from which life may have been formed on larger planets. On March 16, this hypothesis was given a new turn by the announcement at the meeting of the New York Academy of Sciences that Prof. B. Nagy, Dr. W. Meinschein and Dr. Hennessy had, by using mass spectroscopic and X-ray methods, found in the carbonaceous material from the meteorite which fell near Orgeuil in France on May 14, 1864, paraffinoid hydrocarbons characteristic of living organisms and hence had, in the opinions of these investigators, provided proof for the existence of life on its presumed parent body. This view is unlikely to go unchallenged, but whatever the final consensus of opinion, the crucial importance of this study of the carbonaceous meteorites¹ is now evident (see also *Science Notes*, p. 245).

The great publicity deservedly given to these observations and deductions has focused the attention of scientists in many countries on the carbonaceous meteorites. Paradoxically, the result may well be, unless appropriate steps are taken in time, to bring the researches to a rapid end by destroying the irreplaceable material on which they are based. There is known to be only some 30 kg. of well-attested carbonaceous meteorites in museums. More, but not much more, may be in the hands of dealers or may be brought to light in other ways. Already these rare bodies are being examined in a dozen or more laboratories, each with a different objective and by methods which render the material useless for further study. This can only result in the exhaustion of the stock unless prompt measures are taken to ensure international co-operation similar to that in the various sections of the International Geophysical Year in the analysis of meteorites by different but complementary methods. The appropriate body for this is clearly the Committee on Space Research of the International Council of Scientific Unions, which, by a slight extension of its terms of reference, might cover bodies coming in from outer space as well as those going out into it. It is hoped that at the forthcoming meeting of the Committee at Florence, the matter can be discussed and appropriate measures taken in time to secure that the maximum of information is obtained from meteorites with the minimum of destruction. —(*Nature*, 1961, **189**, 967.)

THE DEVELOPMENT AND THE FUTURE OF PHYSICS

THE exciting prospects of physics was the theme of the first Presidential Address to the recently amalgamated Institute of Physics and Physical Society given by the President Sir John Cockcroft in London on 2 May. In it he made a rapid survey of recent and early developments in solid-state physics, mentioning among other things transistors, tunnel diodes, semiconductors, optical masers, modern electronic valves and artificial diamonds. Here, perhaps, he remarked "are a sufficient number of examples to show the creative power of physics in one single field".

Atomic energy development, he reminded his audience, has provided another major demand for physicists, and their work ranged from determining nuclear data to the prediction of kinetic behaviour of reactors and the study of radiation damage. Then there was the important group of physicists engaged in atomic physics research. Sir John's view was that controlled fusion research is likely to remain in the basic research stage for some considerable time yet.

Studies of nuclear structure, the President thought, were likely to have at least ten to twenty further years of interesting life. Space research he thought seemed likely to outstrip nuclear physics research both in glamour and expense in the U.S. and U.S.S.R. He thought it very remarkable how the advent of rockets, with their prestige and military implications, had brought the once greatly neglected field of astronomy into the full limelight. The military and disarmament interest in the detection of underground explosions has had a similar effect on the earth sciences and seismology in particular. Molecular biology and biophysics, though employing few physicists at present, were already becoming of major importance; it is a field in which physicists can have a powerful influence.

Sir John stressed the importance of international co-operative efforts in providing the expensive equipment now needed for fundamental research in physics such as bubble chambers, particle accelerators, large computers and equipment for space research.

RAMAN SPECTRUM OF DEUTERATED METHANE (CD_4)

The latest communication in the series of contributions from the McLeanian Laboratories, University of Toronto, on high-resolution studies of Raman Spectra, Olafson, Thomas and Ich have presented recent results on the spectrum of methane- d_4 (CD_4) (Canadian J. Phys., 1961, 39, 419).

Heavy methane, like ordinary methane (H_4), is a spherical-top molecule (point-group T_d), and has four normal modes of rotation, one totally symmetric $r_1(a_1)$, one doubly degenerate $r_2(e)$, and two triply degenerate $r_3(f_1)$ and $r_4(f_2)$, all of which are active in the Raman effect. In the present investigation Raman spectrum photographs were taken with a newly developed grating spectrophotograph of high light-power, and having a reciprocal linear dispersion of 6 cm^{-1} per mm. at 38 A, and a practical resolving power of 4 cm^{-1} , have enabled precision analysis of the rotational structure of the r_2 and r_4 bands to be effected leading to a more accurate fixation of the constants involved.

The Raman tube, 1.1 metre long with a bore of 1.7 litre, was equipped with a multi-reflection mirror system, and was irradiated by four hairpin-shaped mercury arcs with

water-cooled electrodes operated at 17 amp. The Raman tube was filled with high purity CD_4 gas to a pressure of 1 atm.

The exposure time for photographing the weak r_2 band excited by 4358, varied from 90 to 115 hours. 84 lines were measured in the shift range 950-1330 cm^{-1} . The permissible rotational transitions followed the selection rules $\Delta J = 0, \pm 1, \pm 2$. Accordingly there should be five branches O, P, Q, R and S. However, analysis showed that the rotational levels of the upper vibrational state were each split into two, an upper and a lower level. Thus out of the ten possible branches, seven were observed in the r_2 band.

Photographs of the r_2 band were obtained both with the line 4047 and the line 4358, the exposure time varying from 12 to 64 hours. In this band the rotational levels of the upper vibrational state are split by the coriolis interaction of the rotational and vibrational motions into three sub-levels. Transitions are allowed to all three sub-levels in Raman scattering; the selection rule $\Delta J = 0, \pm 1, \pm 2$, thus gives 15 bands in the rotational structure. 202 lines were measured in the shift region 1950-2500 cm^{-1} . 60 of these lines in the region 1950-2115 cm^{-1} belonged to the r_2 , $2r_2$ and $r_2 + r_4$ bands. The remaining 142 lines

in the region 2110-2500 cm.⁻¹ could be analysed into 13 of the possible 15 branches of the ν_3 band.

From these analyses the length of the C-D bond could be calculated. The effective bond

length, r_0 (C-D), was found to be 1.09181 ± 0.00029 Å. The corresponding value for methane, r_0 (C-H), is 1.09403 ± 0.00016 .

EVOLUTION AS A TEST FOR ETHICS*

TWENTY years ago, Professor Waddington wrote a book on "Science and Ethics" to which his present book *The Ethical Animal* is a sequel. He does not try, as some critics have stated, to derive ethics from a study of evolution. He believes, however, that evolution helps us to judge between different ethical systems. Here are his exact words (p. 30) "We have first to try to ascertain the general character of human evolution or indeed of animal evolution as a whole. We have then to enquire, of any particular ethical belief which comes to our attention, how effective it is in mediating this empirically ascertained course of evolutionary change."

The same ideal was expressed over three centuries ago, by Chapman in Clermont's speech in "The Revenge of Bussy d' Ambois", who held

"That in this one thing all the discipline
Of manners and of manhood is contained ;
A man to join himself to the universe
In its main sway, and make, in all things fit
One with that All, and go on, round as it."

I think that this is a noble fallacy, but yet a fallacy.

I do not think we know enough about the universe, or even about evolution on our planet, to use our knowledge as a test of ethical systems. It is possible that on the basis of messages received from the artificial satellite circling round our planet, the inhabitants of one of the planets of Tau Ceti or Delta Pavonis are at present saying something like this about our species. "The inhabitants of G₁ 17898 III have now reached the stage of technical knowledge when they will be able to exterminate one another completely. Judging from their past behaviour it is certain that they will do this. On all the 7319 planets known to us where living beings descended from carnivorous ancestors learned to promote nuclear fission they killed one another. The best hope for the survival of such a species is the appearance of a series of tyrants who massacre in the name of some religious belief. This checks the growth

of physical knowledge. Unfortunately for the species now dominating the planet in question it did not produce enough men of the type of Charlemagne and Mahmoud of Ghazni, and is in consequence now doomed. From a broader point of view this is a welcome prospect, as some herbivorous species devoid of fighting instincts may possibly evolve a high brain organization on this planet in the next hundred million years".

I do not happen to believe this, but I think it entirely possible that it may be true. Waddington's mind seems to move in the rather narrow set of intellectual grooves fashionable in modern Britain. Thus on page 35 he writes of philosophy as "understood by the most influential modern school, the followers of the later Wittgenstein". This school is not very influential compared with many older (and in the reviewer's opinion more intellectually coherent) philosophies such as Thomism and Vedantism. And its influence is negligible compared with that of Marxism as developed by Lenin, which is a modern school. Waddington may believe that Marxism is false, but if he thinks it is less influential than the school of Wittgenstein, he is blind to historical fact.

I do not even believe in Waddington's account of how man became an ethical animal. I think our ancestors underwent a rather sudden change of habitat, perhaps a "fall" from trees, which rendered their ancestral instincts incompatible with survival. They lost most of them, which enabled them to start technology; but to perform the functions of instincts they had to produce ethics. The human needs for ethics may be a temporary and unhappy phase in evolution.

In spite of all these criticisms the book contains some interesting bits of thought, and I hope that it will stimulate others to more constructive criticism than my own. I hope it will be widely read in India. But if so I trust that nobody will say "The teaching of modern evolutionary biology, as Waddington has shown, is....". When we have studied evolution for two thousand years we may be able to use it as an ethical criterion. Or we may not.

* *The Ethical Animal*. By C. H. Waddington. (George Allen and Unwin, Ruskin House, 40, Museum Street, London, W.C. 1), 1960. Pp. 230. Price 25 sh.

LETTERS TO THE EDITOR

ABSORPTION CROSS-SECTIONS FOR
THE NUCLEAR SCATTERING OF
HIGH ENERGY NUCLEONS

In a previous note¹ a characteristic nuclear transparency curve was shown to exist from the experimental values of σ_a at 305 MeV, 860 MeV and 1.4 BeV. Recently extensive experimental data on absorption cross-sections are available at 140 MeV,² 300 MeV,³ 350 MeV,⁴ 650 MeV,⁵ 765 MeV,⁶ 860 MeV,⁷ 895 MeV,⁸ 900 MeV,⁹ 910 MeV,¹⁰ 970 MeV,⁹ 1.4 BeV,¹⁰

3.6 BeV¹¹ and 4.0 Bev¹² for Be, C, Al, Cu, Sn, Pb, Bi and U.

In the present investigation experimental values of σ_a , at these energies, have been used and γ_2 has been calculated for each element from the experimental values of σ_{pp} and σ_{np} as given by Chen *et al.*¹³ The plot of $\sigma_a/2\pi A^{2/3}$ with the corresponding errors, against the independent parameter γ_2 , is shown in Fig. 1. It is clear that all the points approximately lie on a smooth curve confirming our original

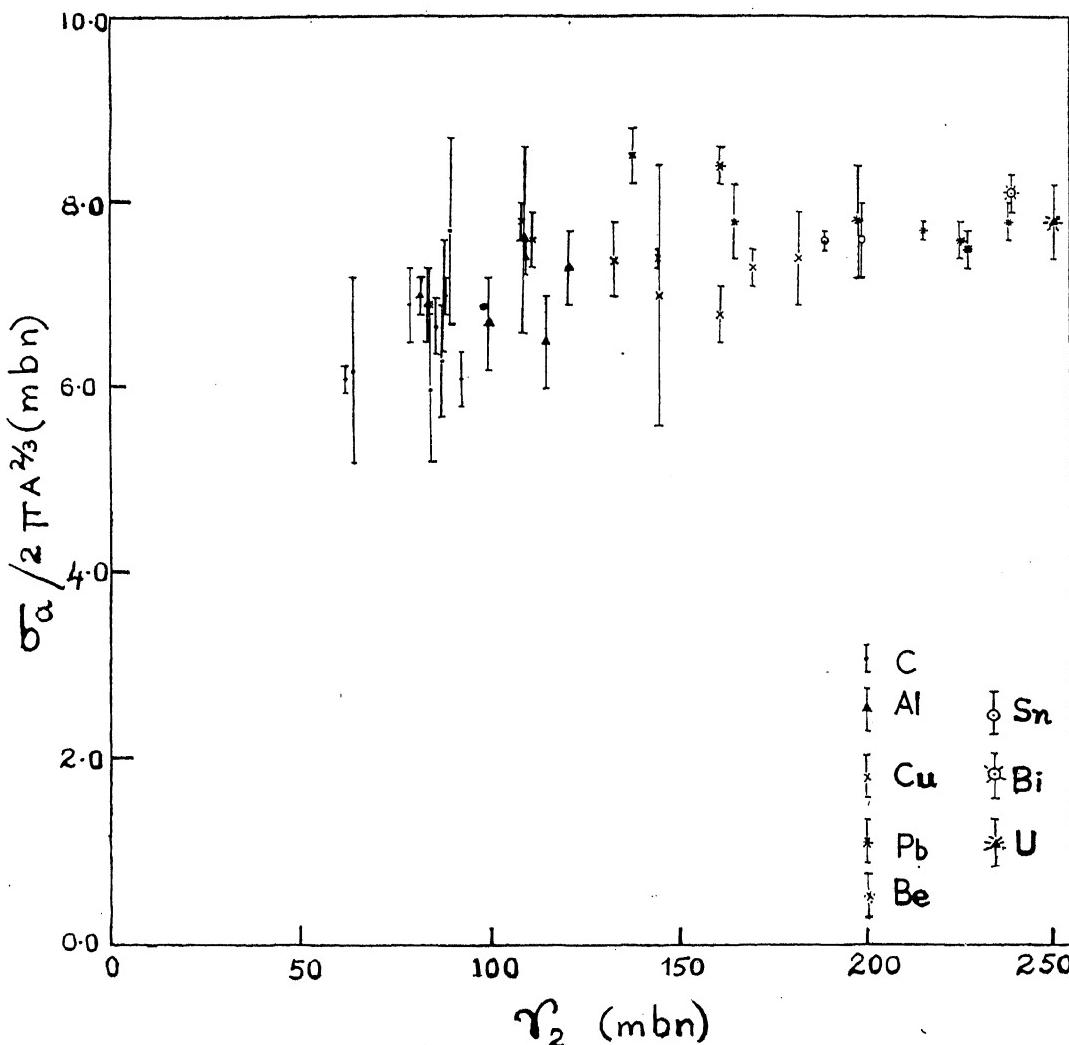


FIG. 1. Study of absorption cross-sections for energies ranging between 140 MeV and 4.0 BeV.

assumption that there exists a characteristic transparency curve. The small deviations may be attributed to the systematic errors in the experimental values of σ_a and the invalidity of the concept of a characteristic nuclear density distribution for heavy elements. We have recently analysed the nuclear scattering of high energy nucleons for middle heavy elements and have noted that a characteristic nuclear density distribution also exists. The details of this work will be published shortly.

Department of Physics,
Bhavan's College,
Andheri, Bombay-58,
April 25, 1961.

G. Z. SHAH.
B. M. THAKER.

1. Gatha, K. M. and Shah, G. Z., *Curr. Sci.*, 1957, **26**, 387.
2. Voss and Wilson, *Proc. Roy. Soc.*, 1956, **41 A**, 236.
3. Ball, B., *U.C.R.L.* (Report 1938, unpublished).
4. Ashmore, A., Mather, D. S. and Sen, S. K., *Proc. Phys. Soc.*, 1958, **71**, 552.
5. Maskalev, V. I. and Gavrilovskii, B. V., *Doklady Akad. Nauk. S.S.R.*, 1956, **110**, 972.
6. Booth, N. E., Ledley, B., Walker, D. and White, D. H., *Proc. Phys. Soc.*, 1958, **71**, 293.
7. Chen, F. F., Leavitt, C. P. and Shapiro, A. M., *Phys. Rev.*, 1955, **99**, 857.
8. Booth, N. E., Ledley, B., Walker, D. and White, D. H., *Proc. Phys. Soc.*, 1957, **70 A**, 209.
9. Batty, C. J., Lock, W. O. and March, P. V., *Ibid.*, 1959, **73**, 100.
10. Coor, T., Hill, D. A., Hornyak, W. F., Smith, L. W. and Show, G., *Phys. Rev.*, 1955, **98**, 1369.
11. Barrett, P. H., *Ibid.*, 1959, **114**, 1374.
12. Sinha, M. S. and Das, N. C., *Ibid.*, 1957, **105**, 1587.
13. Chen, F. F., Leavitt, C. P. and Shapiro, A. M., *Ibid.*, 1956, **103**, 211.

ELECTRONIC TRANSITION MOMENT VARIATION AND VIBRATIONAL TEMPERATURE

LEARNER AND GAYDON¹ have recently pointed out that rotational temperature of a band system is affected by the vibration-rotation interaction. James² has pointed out that such interaction is closely related to the effect of the variation of R_e , the electronic transition moment, with the internuclear separation r , and that a neglect of this interaction can lead to apparently abnormal temperatures. In fact, while studying the variation of R_e with r in BeO ($B^1\Sigma \rightarrow X^1\Sigma$) band system, Sreedhara Murthy³ has made a specific point that in the derivation of temperature from vibrational intensity distribution, account need be taken of the variation of R_e with r . The paper describes the method of estimating the vibrational temperature of BeO

(blue-green) system by incorporating the effect of R_e variation.

DERIVATIONAL PROCEDURE

(a) If R_e is considered not to vary with r , i.e., R_e is constant, we have the following expression from the vibrational sum rule, assuming Maxwell-Boltzmann distribution at a temperature T :

$$\sum_{v''} \frac{I}{v^4} = AN'_v (P_{v', r_0} + P_{v', r_1} + P_{v', r_2} + \dots)$$

$$= AN'_v = AN_0 e^{-E_v'/kT}$$

where A = constant

(1)

If a graphical plot of $\log_{10} \sum_{v''} I/v^4$ against E_v' is made it should give a straight line, the slope of which yields the effective vibrational temperature.

(b) With R_e as a variable in r , the expression (1) modifies to

$$\sum_{v''} \frac{I}{v^4} = AN'_v P_{00} \left(\frac{P_{v', r_0}}{P_{00}} + \frac{P_{v', r_1}}{P_{00}} + \dots \right)$$

$$= AN'_v P_{00} \sum_{v''} \frac{P_{v', v''}}{P_{00}}$$

or,

$$\frac{\sum_{v''} \frac{I}{v^4}}{\sum_{v''} \frac{P_{v', v''}}{P_{00}}} = AN'_v P_{00} e^{-E_v'/kT}. \quad (2)$$

The plot of

$$\log_{10} \frac{\sum_{v''} \frac{I}{v^4}}{\sum_{v''} \frac{P_{v', v''}}{P_{00}}}$$

against E_v' should give a straight line, the slope of which again yields the vibrational temperature.

Tawde and Sreedhara Murthy⁴ have obtained the quantitative integrated intensity data on the bands of BeO ($B \rightarrow X$) system excited in a steady carbon arc source at atmospheric pressure by accurate method of photographic photometry, and have derived the I/v^4 values of the bands therein. The same authors have used the overlap integrals⁵ and r -centroids⁶ and given a set of smoothed transition probabilities, $P_{v', v''}/P_{00}$ taking into account the R_e variation⁴ for this band system. These values have been used here for the evaluation of the effective vibrational temperature. The molecular constants needed for this evaluation are taken from the compilation of Herzberg.⁷ In each case accurate determination of temperature is made by using the least square technique of fitting the straight line graph.

RESULTS AND DISCUSSION

The temperatures derived are recorded below:

- (a) With R_e as a constant: $T = 4840^\circ\text{K}$.
- (b) With R_e as a variable in r : $T = 4000^\circ\text{K}$.

Estimate of percentage error in the result is of the same order in both the cases. The values, in general, are in accord with the expectations from the postulate of a temperature gradient in the carbon arc extending from the core to the surrounding flame zones¹⁰ and "optimum temperature" of the molecule.¹¹ The results further indicate that the inclusion of R_e variation is a significant factor to be considered in the derivation of temperature of a source from band intensity studies, a point that has so far not been well emphasised. The trend is generally to bring down the excessive vibrational temperature values and this in the right direction.

One of the authors (N. S. M.) is grateful to the Ministry of Education, Government of India, for the award of a Senior Research Training Scholarship.

Dept. of Physics, N. R. TAWDE
Karnatak University, N. SREEDHARA MURTHY,
Dharwar, April 28, 1961.

* Now, Post-Doctoral Senior Research Fellow of the National Institute of Sciences of India; on leave from the Central College, Bangalore.

1. Learner, R. C. M. and Gaydon, A. G., *Nature*, London, 1959, **183**, 242.
2. Lame, T. C., *J. Chem. Phys.*, 1960, **32**, 1770.
3. Sreedhara Murthy, N., *Ph.D. Thesis*, Karnatak University, Dharwar, 1958.
4. Tawde, N. R. and Sreedhara Murthy, N., *Proc. Ind. Acad. Sci.*, 1960, **51**, 219.
5. — and —, *Physica*, 1960, **25**, 610.
6. — and —, *Bull. Soc. Ker. A. Ziege*, 1960, **29**, 325.
7. Herzberg, G., *Spectra of Diatomic Molecules*, 2nd Edition, D. Van Nostrand Co., New York, 1950, p. 509.
8. Tawde, N. R. and Trivedi, S. A., *Proc. Phys. Soc. (London)*, 1959, **51**, 733.
9. — and Hussain, A. G., *Res. Comm. Indian Acad. Sci.*, 1949, **17**, 12.
10. —, *Phys. Rev.*, 1946, **70**, 432.
11. Cohen, F. P. and Cohen, F. M., *Z. Phys.*, 1946, **69**, 240.

THE EFFECT OF SIXTH DEGREE CUBIC FIELD ON RARE EARTH IONS IN CRYSTALS

MAGNETIC measurements (Jackson, 1935) on powder crystals of octahydrated sulphate of Neodymium and Erbium between the range 290° and 14° K. show that the strength of the cubic field in $\text{Er}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ is very small compared to that in $\text{Nd}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$. This result is rather surprising. As the salts are

isomorphous and their molecular volumes cannot differ greatly one would expect the crystalline fields in them to be similar, so far as strength and symmetry are concerned.

In order to get an insight into the above-mentioned discrepancy we have measured the magnetic anisotropy and the principal moments of $\text{Er}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ single crystals from 300° to 80° K. by well-known methods (Krishnan *et al.*, 1939; Böge, 1947). The anisotropy is 0.10 for $\text{Er}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ and 0.11 for $\text{Nd}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ at 300° K. Thus the anisotropy is by no means small. Each rare-earth ion in the crystal has at least this amount of anisotropy; probably the anisotropy is more, since in general, there will be more than one unit in the unit cell of the crystals and all these units will not be oriented parallel to one another.

Hence the problem of explaining the observed magnetic properties of these crystals in terms of the magnitude and symmetry of the field associated with each ion, and the orientation of the field axes of these ions relative to one another, becomes extremely complicated.

It is however fortunate that in the rare-earth ion salts, the mean of the three principal moments of the crystals is determined to a first approximation by the cubic part of the field (Mookherji, 1949), so that one may obtain from the observed mean moment a general estimate of the cubic field, and from the anisotropy the non-cubic field. Thus we find that the mean moments of this crystal can be represented to a first approximation by a single suitable cubic field ($a = 0.0135 \text{ cm.}^4$) which is almost the same at all temperatures in the range studied as shown in Table I.

TABLE I

Temperature "K."	300	200	140	100
μ_{obs}	9.48	9.26	9.27	9.33
μ_{cal}	9.61	9.62	9.60	9.68

Calculated values (μ_{cal}) were obtained by using the expression as given by Spedding (1937) in which the cubic field used is regarded as of the fourth degree. According to Kynoch (1937) the splittings of the energy levels of Nd^{+3} and Er^{+3} and hence the magnetic moments depend on whether the cubic field involves only the fourth degree terms or in addition sixth degree terms also. In case of Er^{+3} the energy levels with the fourth degree field alone are 0, 19, 38, 85 and 89 cm.⁻¹ while for the combined field they are 0, 19, 27, 35 and 85.6 cm.⁻¹

At low temperature the moment values of the salts will depend mainly on the lowest levels. As is seen the inclusion of the sixth degree field depresses energetically one of the levels while the other two come very close.

Thus though the mean magnetic moments can be explained approximately on the basis of a single suitable cubic field of the fourth degree, the absolute magnitude of the fourth degree field estimated in this way will not be correct as the sixth degree terms of the cubic field influence the moments and the magnitudes of the fourth degree, and sixth degree terms in these crystals are not known.

Work is in progress with fields of tetragonal symmetry to get a fit with magnetic anisotropy and its variations with temperature.

Details will be published elsewhere.

Physical Laboratories, A. MOOKHERJI.
Agra College, Agra (India), D. NEOGY.
May 9, 1961.

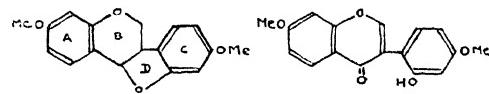
1. Bose, A., *Ind. Jour. Phys.*, 1947, **21**, 275.
2. Jackson, L. C., *Proc. Phys. Soc. London*, 1935, **47**, 1027.
3. Krishnan, Mookherji and Bose, *Philos. Trans.*, 1939, **238**, 125.
4. Kynch, *Trans. Farad. Soc.*, 1937, **33**, 1402.
5. Mookherji, A., *Ind. Jour. Phys.*, 1949, **23**, 309, 410.
6. Spedding; F. H., *J. Chem. Phys.*, 1937, **5**, 316.

SYNTHESIS OF A RACEMATE OF HOMOPTEROCARPIN

PTEROCARPIN and homopterocarpin are two tetracyclic compounds¹ related to isoflavones but so far no successful attempts have been made to synthesise them. In the course of exploratory work for establishing interrelationship among isoflavanoids, it has now been possible to synthesise homopterocarpin (I) using 7 : 4'-dimethoxy-2'-hydroxy isoflavone ($C_{17}H_{14}O_5$) (II) (m.p. 183–84°) as the main intermediate. This isoflavone has been prepared using special methods.

Among the number of methods investigated for reducing the oxygen ring and constructing the D ring of the homopterocarpin, the use of sodium borohydride has been most successful. Reduction of both the double bond and the carbonyl group takes place with this reagent. In this respect we confirm the findings of Miyano and Matsui² on the reduction of dehydro-rotenone and related compounds. We have observed that the reduction of the isoflavone (II) with sodium borohydride in tetrahydrofuran-alcohol medium yields directly a racemic mixture of homopterocarpin (m.p. 129–30°)

almost in quantitative yield. The structure was established by comparison with a natural sample of (–) homopterocarpin using ultra-violet and infra-red spectra both taken in chloroform which were found to be identical. The method seems to be of general utility and its use is being extended for the synthesis of related compounds.



I

II

FIG. 1

Satisfactory analysis has been obtained for compounds mentioned in this communication.

We convey our thanks to Dr. W. B. Whalley for providing us with a specimen of natural homopterocarpin.

Department of Chemistry, K. AGHORAMURTHY.
University of Delhi, A. S. KUKLA.
Delhi-6, May 12, 1961. T. R. SESADRI.

1. McGookin, Robertson and Whalley, *J.C.S.*, 1940, 780; 1954, 1440.
2. Miyano and Matsui, *Chem. Ber.*, 1958, **91**, 2044.

ENHANCED REDUCTION EFFICIENCY OF SODIUM BOROHYDRIDE IN THE PRESENCE OF TITANIUM TETRACHLORIDE

BROWN AND SUBBA RAO^{1,2} reported that esters undergo rapid reduction even under mild conditions with sodium borohydride in the presence of certain polyvalent metal halides. The system $NaBH_4\text{-AlCl}_3$ was examined in detail regarding the reducing action on several organic functional groups, while the system $NaBH_4\text{-TiCl}_4$ was tried only for the reduction of esters. As the latter exhibited certain peculiarities, its full scope has now been investigated.

The procedure adopted in the reduction studies was quite simple. First the reagent was prepared by mixing diglyme solutions (1·0 M) of $NaBH_4$ and $TiCl_4$ in the ratio of 4 : 1. Then, to the cooled and stirred reagent (present in excess), the compound to be reduced was added slowly either by itself or in diglyme solution. After 3 hours' reaction at room temperature the reaction mixture was hydrolysed with dil. acid and the reduction product isolated in the usual way.

Thus, carrying out reductions on 10–50 m. mole scale, the following compounds have been reduced and the corresponding reduction products isolated in 70–90% yield:

m-Chloro-*p*-methoxy methyl benzoate → *m*-chloro-*p*-methoxy benzyl alcohol.

Methyl crotonate → Crotonyl alcohol.

m-Methoxy benzoic acid → *m*-methoxy benzyl alcohol.

p-Nitrobenzoic acid → Mixture of products having nitro-group reduced to varying stages and acid group reduced to alcohol.

Crotonic, oleic and cinnamic acids → Corresponding alcohols, also hydroborated at the double bond.

Benzamide, lauramide → Benzamide, lauramide (salt formed but regenerated on hydrolysis).

Benzoyl chloride, *n*-butyryl chloride → Corresponding alcohols.

Diethyl phthalate, diethyl adipate → Corresponding diols.

Phthalic anhydride → Corresponding diol.

Succinic anhydride → Incomplete reaction.

Benzonitrile, acetonitrile → Corresponding amines (V. slow).

Nitrobenzene → Azobenzene, hydrazobenzene and small amounts of phenylhydroxylamine.

Cyclohexene and hexene-1 → Corresponding organoborane.

It is clear that this reagent $\text{NaBH}_4\text{-TiCl}_4$, unlike the selective yet powerful $\text{NaBH}_4\text{-AlCl}_3$, has no selectivity and behaves more like lithium aluminium hydride by reducing practically all common organic functional groups. The very mild and selective reducing agent, NaBH_4 , can thus be transformed to a powerful reducing agent by the addition of equivalent amounts of TiCl_4 and could be used where a strong reducing and hydroborating agent is needed.

National Chem. Lab., B. C. SUBBA RAO.
Poona-8, April 28, 1961.

1. Brown, H. C. and Subba Rao, B. C., *J. Am. Chem. Soc.*, 1955, **77**, 3164.
2. — and —, *Ibid.*, 1956, **78**, 2584.

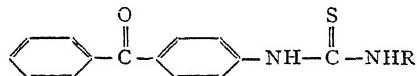
SYNTHESIS OF THIOUREIDO-BENZOPHENONES

BENZOPHENONE has a weak anticonvulsant effect.¹ Aminoketones show weak local anaesthetic properties. Several organic compounds have been found to afford considerable prophylactic protection against lethal doses of Rontgen rays. Among them are thiourea and *p*-aminopropiophenone.² Thiourea was the first drug to be used in human thyrotoxicosis before thiouracil became available.³ It is found that $\text{N}-\text{CS}-\text{N}$ grouping is responsible for goitrogenic behaviour. With these views in mind, it was of interest to synthesize thioureas having benzophenone as a substituent on

nitrogen of thioureido system for studying their goitrogenic effect. Compounds synthesized are described in Table I and their goitrogenic effect shall be reported elsewhere.

p-Aminobenzophenone was prepared according to Kursanov.⁴ This was condensed with the corresponding isothiocyanates prepared according to the author,⁵ by the method described previously in this journal.⁶ Compounds are listed in Table I. All melting points are uncorrected.

TABLE I
Thicureido-benzophenones



No.	R =	M.P. °C.	Analysis	
			Theoret.	Found
1	<i>o</i> -ClC ₆ H ₄ -	..	58-59	8.7 8.6
2	<i>m</i> -ClC ₆ H ₄ -	..	84	8.7 8.5
3	<i>m</i> -CH ₃ C ₆ H ₄ -	..	55-56	9.2 9.1
4	<i>p</i> -CH ₃ C ₆ H ₄ -	..	70	9.2 9.3
5	<i>p</i> -n-C ₄ H ₉ O-C ₆ H ₄ -	..	76	7.9 7.8
6	<i>p</i> -n-C ₇ H ₁₇ O-C ₆ H ₄ -	..	95	8.2 8.2
7	<i>p</i> -OCH ₃ C ₆ H ₄ -	..	90-91	8.8 8.6
8	<i>o</i> -OCH ₃ C ₆ H ₄ -	..	135	8.8 8.8
9	C ₆ H ₅ CO-	..	148	8.9 8.6
10	(C ₆ H ₅) ₃ C-	..	77-79	6.4 6.4
11	C ₆ H ₅ CH ₂ -	..	53-54	9.2 9.1
12	<i>p</i> -ClC ₆ H ₄ CH ₂ -	..	59	8.4 8.3
13	<i>p</i> -n-C ₄ H ₉ O-C ₆ H ₄ CH ₂ -	..	87	7.7 7.7
14	<i>o</i> -BrC ₆ H ₄ CH ₂ -	..	81	7.5 7.4

Authors thank Dr. N. M. Shah for interest in the work.

Department of Chemistry, A. A. MUNSHI.
St. Xavier's College, J. P. TRIVEDI.
Ahmedabad-9, February 16, 1961.

1. Burger, *Medicinal Chemistry*, Interscience, 1953, **1**, 143.
2. Storer and Coon, *Proc. Soc. Exp. Biol. Med.*, 1950, **74**, 202.
3. Astwood, *J. Am. Med. Assoc.*, 1943, **122**, 78.
4. Kursanov, D. N., *J. Gen. Chem. U.S.S.R.*, 1943, **13**, 286.
5. Trivedi et al., *J. Ind. Chem. Soc.*, 1956, **33**, 423.
6. Satpanthi and Trivedi, *Curr. Sci.*, 1960, **29**, 346.

MOLYBDATE-TUNGSTATE ANTAGONISM IN NEUROSPORA CRASSA

CONCLUSIVE evidence for the specific involvement of molybdenum in nitrate assimilation in *Neurospora crassa* has been obtained by the isolation and characterisation of nitrate reductase, a molybdenum containing enzyme.¹

However, it has been observed that molybdenum may be required by fungi for biochemical functions other than for reduction of nitrate^{2,3}. That tungstate acts as a specific antagonist of molybdate utilisation was shown in rat,⁴ chick,⁵ *Aspergillus niger*⁶ and *Azotobacter vinelandii*.⁷ The possible role of tungstate as an inhibitor of molybdate utilisation in a wild strain of *Neurospora crassa* (Em 5297 a) has been investigated and is presented in this note.

The composition of the basal medium used was the same as that of Horowitz and Beadle, as modified by Nicholas and Commissiong⁸ and had the following composition in gm. per litre: D-glucose-20 :, KH₂PO₄-3 :, NH₄NO₃-2 :, ammonium tartrate-1 : MgSO₄·7H₂O-0.5 :, NaCl and CaCl₂-0.1 (each) and the following trace elements in microgram per litre: Zn-200 :, Mn-200 :, Cu-80 :, and Fe-20. In addition, biotin was added at a level of 5 microgram per litre of the medium. In the case of minimal nitrate medium, sodium tartrate (5 gm./litre) was substituted for ammonium tartrate⁹ and sodium nitrate (3 gm./litre) for ammonium nitrate and the pH was adjusted to 5.5 and in the case of minimal ammonium medium molybdate was omitted and ammonium tartrate was substituted for ammonium nitrate on an equivalent nitrogen basis. For minimal organic nitrogen medium, DL-alanine (9.3 gm./litre) and sodium tartrate (5 gm./litre) were substituted for ammonium nitrate and ammonium tartrate and molybdate was omitted. 25 ml. of the medium with necessary substrates were dispensed in 250 ml. conical flasks and then sterilised at 15 pounds per square inch pressure for 10 minutes. The inoculum was prepared by suspending in water, washed spores from a 5 to 6 days old slant. One or two drops of the spore suspension was added per flask and the incubation was carried out at room temperature (28 to 30° C.) for 72 hours. The mycelia were then collected, washed, partially dried by filter-paper and then dried to constant weight at 60° C. The fully dried mycelia were then weighed in a Roller-Smith torsion balance.

The macro-nutrients may contain molybdenum, as a contaminant sufficient to support growth of the organism, even without addition of molybdate to the medium. Hence contaminant molybdenum was removed from the inorganic macro-nutrient solution and dextrose by the method of Nicholas.¹⁰ Only pyrex brand glassware, washed with chromic acid, rinsed with hot distilled water several times and finally with glass-distilled water, was used. Glass double distilled water was used throughout.

The results of the investigation of tungstate as an antagonist of molybdate in *Neurospora crassa* grown on different nitrogen sources are presented in Table I. It can be seen from

TABLE I
Effect of tungstate on the growth of *Neurospora crassa* on different sources of nitrogen

Medium*	Molybdenum supplemented to the basal medium (10 ⁻² mμM/flask)	72 hours growth of mycelium (Dry weight in mg.)
Nitrate (No tungstate)	..	125.0
Nitrate	..	50.0
do.	..	7.8
Nitrate and ammonia (no tungstate)	..	115.0
Nitrate and ammonia	..	100.0
do.	..	55.0
Ammonia (no tungstate)†	..	102.0
Ammonia	..	100.0
DL-Alanine (no tungstate)†	..	123.0
DL-Alanine	..	120.0

* Where specifically not stated otherwise, tungstate was also added to provide 81.6 mM. W./flask.

† 5.21 × 10⁻³ mμM. molybdenum in the basal medium was omitted in these cases.

Table I that tungstate inhibits the growth of *Neurospora crassa*, in media containing nitrate or nitrate and ammonia, as the sole source of nitrogen. Molybdate reverses the growth inhibition produced by tungstate. This suggests that as in other organisms^{2,3} tungstate produces an apparent molybdate deficiency in *Neurospora crassa* also and inhibits certain biochemical processes in which molybdate participates. Tungstate has no effect on the growth of *Neurospora crassa* grown on media having ammonium tartrate or organic nitrogen as sole nitrogen source and under these culture conditions, nitrate reductase has no function and has actually been shown to be absent.⁵

Further work on tungstate-molybdate inter-relationship using radioactive isotopes is in progress and will be published in detail elsewhere.

A. RAMAIAH.

E. R. B. SHANMUGASUNDARAM.

University Biochemical

Laboratory, Madras-25,

February 22, 1961.

1. Nicholas, D. J. D., Nason, A. and McElroy, W. D., *J. Biol. Chem.*, 1954, **207**, 341 and 353.
2. Mulder, E. G., *Plant and Soil*, 1948, **1**, 94.
3. Agarwala, S. C., *Nature*, 1952, **169**, 1099.
4. De Renzo, E. C., *Ann. New York Acad. Sci.*, 1954, **57**, 905.
5. Higgins, E. R., Richart, D. A. and Westerfeld, W. W., *J. Nutrition*, 1956, **59**, 539.

6. Higgins, E. R., Richard, D. A., and Wasterfeld, W. W., *Proc. Soc. Exptl. Biol. and Med.*, 1957, **92**, 509.
7. Keefer, R. F. and Varner, J. E., *Arch. Biochem. and Biophys.*, 1957, **70**, 585.
8. Nason, A. and Evans, H. J., *J. Biol. Chem.*, 1953, **202**, 655.
9. Nicholas, D. J. D. and Commissiong, K., *J. Gen. Microbiol.*, 1957, **67**, 699.
10. —, *Analyst*, 1952, **77**, 629.

**STROMATOLITES IN LOWER
CUDDAPAH LIMESTONES
(PRECAMBRIAN) IN CUDDAPAH BASIN**

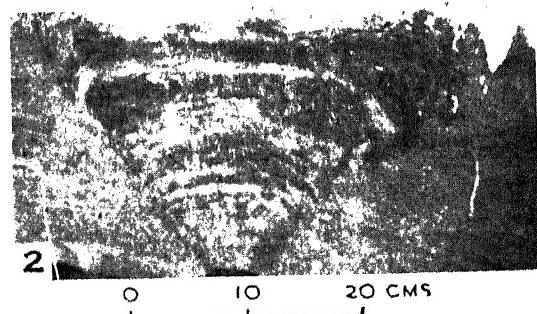
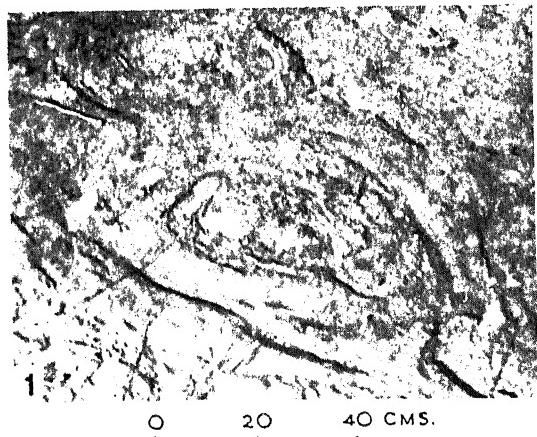
KING¹ reported the rocks of Cuddapah System (Precambrian) in Andhra Pradesh to be devoid of any fossils. Srinivasa Rao² recorded the occurrence of algae in limestones of Cuddapah age near Rayalacheruvu in Anantapur District. During the course of field-work among the Lower Cuddapahs in the western part of Cuddapah Basin, the author has observed some features in limestones of both the Vempalle and Tadpatri stages of Lower Cuddapahs. Of these, while some are oolites and concretions, many are stromatolites, laminated structures attributed or possibly attributable to the work of blue-green (or green) algae. This note records one of the occurrences observed.

A bed of gray limestone is exposed in a stream flowing north, near the milestone 3/3 between the villages of Puliyyenda and Velidendla in Cuddapah District. About 30 feet north of the causeway across the stream in an exposure which abounds in forms of the type shown in Fig. 1. The bed strikes N 45° W S 45° E and dips 10° due north-east. The detached outcrops of the limestone with the algal colony occupy an area of 40 feet by 30 feet. Figure 1 shows the top view of the stromatolites, and Fig. 2 the vertical section across one such form. Comparison of these figures with the various types illustrated and described by Rezak³ shows that these may be tentatively placed in the form genus *Coffenia*. Harlan Johnson⁴ is also of the same view.

From a study of the ancient and modern stromatolites, Logan, Rezak and Ginsburg have come to certain conclusions regarding the light these throw on the environments of deposition. A detailed paper on the various other forms of stromatolites met with in this part of the Basin together with their significance will be published elsewhere.

I am grateful to Professor C. Mahadevan for his kind interest in this study. My thanks are due to Professor J. Harlan Johnson, Professor

Emeritus, Colorado School of Mines, Golden, Colorado, and Richard Rezak, Shell Develop-



Figs. 1-2

ment Company, Houston, Texas, for their critical comments and confirmation of the identification.

Geology Department,
Andhra University,
Waltair, May 9, 1961.

R. VAIDYANADHAN.

1. King, W., *Mem. Geol. Surv. Ind.*, 1872, **8**, 37.
2. Srinivasa Rao, M. R., *Curri. Sci.*, 1943, **12** (7), 207.
3. Rezak, R., *U.S.G.S. Prof. Paper*, 1957, **294 D**, 127.
4. Harlan Johnson, J., Personal Communication.
5. Logan, B. W., Rezak, R. and Ginsburg, R. N., *Abstr. G.S.A.*, 1961, **71** (12), part 2, 1918.

SEPARATION OF RARE EARTHS

SEPARATION of rare earths into their individual components has become one of the most important problems for the present-day chemists. The existing method is separation by ion exchange. One of the authors had previously tried to decompose monazite by heating it with a mixture of calcium oxide and calcium chloride

and leaching the sintered product with dilute acid by which he separated the soluble phosphate from the monazite. The same technique has been tried for the separation of the individual components of rare earths.

Rare earth chloride supplied by the Indian Rare Earth Ltd., Alwaye, was mixed with calcium oxide and calcium chloride and heated in a silica tube to a temperature of 1,000°C. At about 640°C. the mixture was seen to be fusing. On cooling the mixture, it was found to have different patches of varying colours. These different patches were separated by scraping and hand-picking and were spectrographically analysed. Each fraction was found to be the concentrate of individual rare earths mixed with calcium and silica.

This leads to the conclusion that the different coloured patches are due to the formation of complex silicates of rare earths and calcium or calcium compounds of rare earths, e.g. calcium lanthanates, etc. By trying different solvents and also taking advantage of differences in solubility of the different compounds, it is hoped to separate the individual rare earths from these complexes.

Further experiments are in progress to separate the rare earths on the lines mentioned above.

National Met. Lab., K. N. KARTHA.*
Jamshedpur, H. V. BHASKAR RAO.**
May 5, 1961.

* Junior Research Fellow.

** Assistant Director.

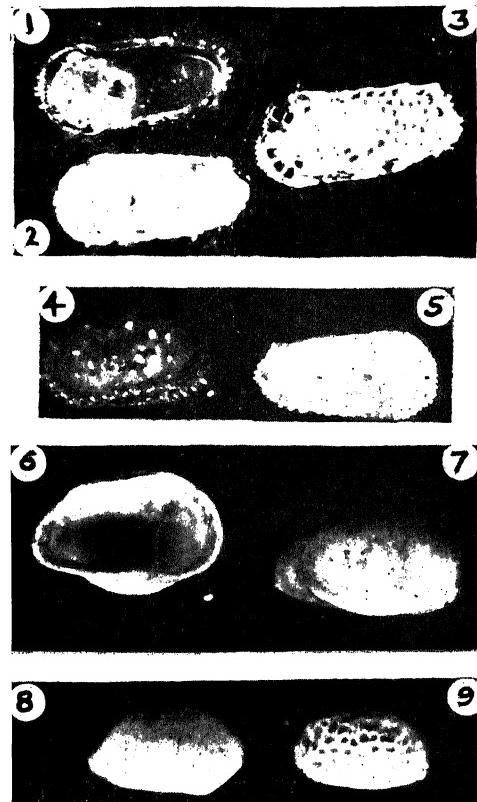
OCCURRENCE OF OSTRACODA IN ROCKS OF PALEOCENE AGE NEAR PONDICHERRY, SOUTH INDIA

THE occurrence of Ostracoda in the Cretaceous-Tertiary area of Pondicherry is noted and here reported for the first time.

In the summer of 1960, I made a systematic collection of rock samples from several Cretaceous and Tertiary outcrops as also from many well sections in the Pondicherry area with a view to making a detailed micropalaeontological and sedimentary petrological study, and thereby attempting a classification of these rocks.

In the course of my examination of the washed residues of a marly limestone for smaller foraminifera I noticed some Ostracodes in the sample, mostly in an excellent state of preservation, of which the more commonly occurring ones are shown in the accompanying photographs. Figures 1 and 2 show the internal features

of the left and right valves respectively of an Ostracod genus belonging to the Trachyleberidae; Fig. 3—exterior of the same genus showing a coarsely and deeply reticulate surface. Figs. 4 and 5—another genus belonging to the same family showing exterior and interior respectively of the left valve; this genus has a smooth surface covered with spines. Figs. 6 and 7 are left and right valves of a genus belonging to Cytheridae showing interior and exterior respectively. Fig. 8—Right valve of *Bairdia* showing exterior. Fig. 9—Right valve of *Hemicythere*? showing exterior.



FIGS. 1-9. Ostracoda from rocks of Paleocene age near Pondicherry, South India. Figs. 1-5, $\times 30$. Figs. 6-9, $\times 40$.

On the strength of the occurrence of *Nummulites* together with *Discocyclina* in "one of the limestones collected from near Valadavur", Rama Rao (1939, 1956) suggested the existence of an Eocene bed in the Pondicherry Cretaceous area. In the sample now at my disposal containing the Ostracodes I have not noticed any *Nummulites*. However, it is interesting to note that the Ostracodes are found associated with *Discocyclina* and a keeled *Globorotalia* which

occur in abundance in the sample, besides several other foraminiferal genera. This faunal assemblage clearly indicates a Paleocene age.¹

A detailed study of the Ostracoda and foraminifera of this horizon is under progress.

Dept. of Geology, N. RAJAGOPALAN,
Annamalai University,
Annamalainagar, April 13, 1961.

1. Rama Rao, L., *Curr. Sci.*, 1939, **8** (4).
2. —, *Proc. Ind. Acad. Sci.*, 1956, **44** (4).

* Dr. M. F. Glassner of the University of Adelaide, who kindly examined the microfauna of this sample in a personal communication writes, "I have no doubt that this assemblage is in fact of Paleocene age. As you say the presence of a keeled *Globorotalia* together with a *Discorbisina* in the assemblage indicates a Late Paleocene age".

SOME OBSERVATIONS ON PIEDMONTITE FROM GOLDONGR MANGANESE MINE

EXAMINATION of some piedmontite-bearing rocks from Goldongri Manganese Mine in the Panchmahals district, Gujarat State, led the author to investigate the optical properties of the mineral to find out whether it is manganeseepidote or piedmontite. The mineral was originally described by Fermor¹ who provisionally identified all the manganese-bearing epidotes occurring in the Indian manganese-ore deposits as piedmontite. However he was aware that the only way to distinguish the manganese epidotes, namely manganeseepidote and piedmontite, is by the determination of the optic sign and the Mn₃O₄ content of these minerals. Since Fermor, no further study of the Goldongri piedmontite seems to have been undertaken.

The mineral occurs as granular to small prisms in the quartzite and the associated gonditic rocks. It varies from 1 to 6 mm in length and is purplish red to deep red in colour. Under the microscope it shows strong pleochroism with X yellow to yellow orange with sometimes a brownish tinge, Y deep violet, Z amethyst to carmine; refractive indices: $\alpha = 1.740$, $\gamma = 1.792$, $(\gamma - \alpha) = 0.052$; XZ plane H" (010), $y = b$; (+) 2V = 78°; X A C = 5.6°.

The optical characters of the mineral, together with the presence of manganese (qualitative test), evidently prove it to be piedmontite and not manganeseepidote, thus confirming Fermor's expectations.

On comparing its optical characters with those of other piedmontites it is seen that it bears a close resemblance with the piedmontite from Shadow Lake, Madera County, Calif-

fornia,² in its pleochroism, refractive indices, optic axial angle, etc. Reviewing the literature it is found that the optical characters as recorded are inadequate, and the pleochroism which is most diagnostic has been given for all occurrences. It is said that the optic axial angle and the intensity of pleochroism increase with the increase of manganese oxide, and therefore it is most likely that the large optic axial angle of the piedmontite under investigation may be due to a large content of manganese oxide.

Other minerals associated with it are spessartite and rhodonite. From the mineral associations it is clear that the mineral is intimately associated with the gondite in the present case, while in other areas in India it does not actually occur in the rocks of this series but in the crystalline limestone of the same neighbourhood. A similar occurrence with gondite is reported from the Kajlidongri mine, Jhabua district, M.P., where it is intimately associated with the gondite.

Regarding its origin, the author concurs with Fermor's opinion that it is a product of the metamorphism of the sediments that contained a fair amount of manganese besides lime, iron and alumina.

Therefore, it may be concluded that the manganese epidote under investigation is a true piedmontite and not manganeseepidote, and is of metamorphic origin.

I am grateful to the Ministry of Scientific Research, Government of India, for the award of a scholarship which has enabled me to carry out this work in the laboratory of the Department of Applied Geology, University of Saugar.

Dept. of Applied Geology, V. K. NAYAK,
University of Saugar,
Saugar (M.P.), February 6, 1961.

1. Fermor, L., *Mem. Geol. Surv. Ind.*, 1909, **37**, Part I, 187.
2. Short, A. M., *Am. Min.*, 1933, **18**, 497.

INSECTICIDAL PROPERTIES OF ZANTHOXYLUM ALATUM LINN.

Nor much information is available on the insecticidal properties of the species belonging to the genus *Zanthoxylum* (Rutaceae).^{1,2} This note presents preliminary observations on the contact toxicity of *Zanthoxylum alatum* Linn., on *Locusta migratoria* L. nymphs. *Z. alatum* Linn. is an armed small tree growing in the foot-hills of the Himalayas. It is also found in the Ganjam hills in South India. Locally it is called "Timru" and "Tejbal", and in the indigenous system of medicine the plant is

noted for its febrifugal, sudorific and diuretic properties and is highly prized as a good dentrifice.

Two sets of experiments were planned to evaluate the toxicity. In the first set 60-mesh powder obtained from air-dried stem bark was used. In the second set, the steam-distilled essential oil from the fruits was used. The fruits yield 1·5% of yellowish essential oil.

In both the sets of experiments one day old nymphs of *Locusta migratoria* L. were used. In each set of experiments fifteen replications were taken each with 10 insects. After the treatment the nymphs were transferred to clean jars and food was provided. The jars were kept at room temperature 26°-29° C. and R.H. 60-70%. Untreated controls were also run side by side.

For the powder treatment the nymphs of each replication were rolled in 0·5 gm. of dust in petri dishes by shaking the dish horizontally until the insects were thoroughly covered with the powder. After one minute they were transferred to clean jars. For testing the oil, the method of Krijgsman and Berger (1949)³ was followed. A 1% stock solution of oil was prepared in ether. 0·5 ml. of this solution was pipetted in the petri dish and by continuous movement the ether was allowed to evaporate till a more or less thin solid film of oil was left on the glass. Similarly the top inner side of the cover of the petri dish was coated by the oil. The insects were introduced and were allowed to move about for one minute and then transferred to clean jars.

When the insects were treated by the powdered bark they immediately started cleaning their appendages, but a brisk movement of antennae, legs and other body parts started after 15 to 20 minutes. They were knocked down after 1½ to 2 hours. In the insects exposed to the oil, contortions of the body parts started immediately after the exposure but they lost their sense of orientation in about 20 minutes.

Counts for the mortality were made after 24 hours and it was observed that the powdered bark gave 100% mortality, whereas the oil gave a mortality of only 40%.

Regional Research Lab.,
Jammuen Tawi,
November 28, 1960.

A. C. MATHUR.
J. B. SRIVASTAVA.
I. C. CHOPRA.

1. Atkinson and Brandis, *vide* George Watt, *A Dictionary of the Economic Products of India*, 1898, 6, 323.
2. Manson, D., *J. Mal. Inst. Ind.*, 1939, 2 (1), 85.
3. Krijgsman, B. J. and Berger, N. E., *Bull. Ent. Res.*, 1949, 40 (3), 355.

ON THE GENUS *CRYPTOCOCCUS* KUTZING EMEND. VUILLEMIN IN INDIA—A PRELIMINARY REPORT

The genus *Cryptococcus* has a widespread geographic distribution. Most of its species have repeatedly been cultured from soil, air and various other sources. A close association of the genus with man, animals (van Uden and Cormo-Sousa¹) and some insects (Shifrine and Phaff²) has been reported. Connell and Skinner³ have found *Cryptococcus albidus*, *C. diffuens*, *C. laurentii* and *C. luteolus* to be a part of the normal saprophytic flora of human skin. di Menna⁴ has cultured these four species from cow's raw milk.

Infections due to *Cryptococcus neoformans*, the only pathogenic species of the genus, are met with both in man and animals. In this country (Vellore, South India) Khan et al.⁵ have isolated *C. diffuens*, *C. laurentii* and *C. luteolus* to be of pulmonary cryptococcosis. Apart from this report very little is known about the occurrence and distribution of the genus *Cryptococcus* in India. During routine mycological studies on sputum and other clinical specimens received in this laboratory the authors collected several isolates of yeasts which were identified according to the methods recommended by Lodder and Kreger Van Rij⁶ and Wickerham.⁷ After verification of the following generic characters seven of the isolates were classified in the genus *Cryptococcus*:

1. Lack of ascospore formation on Gorodkowa agar and potato and carrot plugs.
2. Absence of pseudomycelium.
3. Presence of capsule around the cells (Fig. 1).



FIG. 1. *Cryptococcus albidus*, India ink preparation showing capsulated yeast cells, $\times 675$.

4. Inability to ferment glucose, galactose, sucrose, maltose and lactose.

5. Synthesis of starch both in the culture medium and the cells.
 6. A positive urease test (Seeliger).⁸

In order to derive at the species, assimilation reactions of the test isolates of *Cryptococcus* were noted on potassium nitrate, glucose, galactose, sucrose, maltose and lactose.

The results are summed up in Table I and from there it follows that 5 isolates belong to *C. diffluens* and one isolate each to *C. albidus* and *C. laurentii*. As far as the authors are aware these species have not been previously recorded from India.

TABLE I
 Assimilation pattern and origin of seven isolates
 of *Cryptococcus* spp.

Name of species	Number of isolates	Source of isolation	Assimilation pattern				
			KNO ₃	Glucose	Galactose	Sucrose	Maltose
<i>C. diffluens</i> (Zach.) Lodder et van Rij	4	Sputa					
	do.	1 Skin scrapings	+	++	++	++	-
<i>C. albidus</i> (Saito) Skinner	1	Sputum	+	++	++	++	+
<i>C. laurentii</i> (Kufferath) Skinner	1	Throat swab	-	+	++	++	+

A detailed description of the above-mentioned three species which showed good agreement with the standard descriptions given for them in the monograph by Lodder and Kreger van Rij,⁶ will be published elsewhere.

The writers are thankful to Dr. Libero Ajello, Communicable Disease Centre, Atlanta, U.S.A., for checking one strain of *Cryptococcus diffluens* and to Dr. R. Viswanathan, Director of this Institute, for his interest and encouragement in this study.

R. S. SANDHU.
 (MRS.) D. K. SANDHU.
 H. S. RANDHAWA.
 S. C. CHAKRAVARTY.

Dept. of Medical Mycology,
 V.P. Chest Institute,
 University of Delhi,
 Delhi-6, March 13, 1961.

3. Connell, G. H. and Skinner, C. E., *Jour. Bact.*, 1953, **66**, 627.
4. di Menna, Margaret E., *Antonie van Leeuwenhoek*, 1956, **22**, 331.
5. Khan, M. J., Ruth Myers, M. S. and Koshy, Grace, *Dis. Chest.* 1959, **36**, 656.
6. Lodder, J. and Kreger van Rij, N. J. W., North Holland Publishing Co., Amsterdam, 1952, Pp. 6-35.
7. Wickerham, L. J., "Taxonomy of yeasts," *U.S. Dept. Agriculture Tech. Bull. No. 1029*, 1951, 2-19.
8. Seeliger, Heinz, P. R., *Jour. Bact.*, 1956, **72**, 127.

**METACERCARIA OF APHANURUS SP.
 (TREMATODA-HEMIURIDAE) FROM
 A COPEPOD ACROCALANUS GRACILIS
 (GIESBRECHT) OFF WALTAIR COAST**

THE occurrence of the metacercariae of hemiurid trematodes of fishes in planktonic copepods have been reported from time to time by various workers. Steuer¹ discussed the geographical distribution and affinities of the appendiculate trematodes parasitising marine planktonic copepods of the northern seas. The occurrence of metacercariae of *Derogenes varicus*, *Hemimurus communis* and *Lecithaster confusus*, in *Acartia* sp. have since been reported by other workers.²⁻⁴ The progenetic metacercaria of *Derogenes varicus* has also been reported from a parasitic copepod, *Lernaeocera lusci* on Gadoid fishes by Dollfus.⁵ The metacercaria of *Bunocotyle cingulata* has been described from a brackish water copepod by Chabaud and Biguet.⁶ Hemiurid larvæ have also been reported from the deep sea copepod *Pleuro-mamma gracilis* by Steuer⁷ and from *Calanus finmarchicus* by Marshall and Orr.⁸ Krishna-swamy⁹ and Sewell¹⁰ have reported the occurrence of hemiurid larvæ in *Paracalanus aculeatus*, *Clausocalanus furcatus*, *Corycaeus gibbulus* and *Oncæa venusta* from the Indian seas.

While examining the plankton collected in the inshore waters off Waltair, some of the copepodites of *Acrocalanus gracilis* were observed to be brick-red in colour owing to the presence of the metacercariae of trematodes in their body cavity. Only a single parasite was harboured by each copepodite. We observed the parasite only on one occasion in an adult host. Incidentally this is the first report of the occurrence of hemiurid metacercariae from the present host and also the first description of the metacercaria of *Aphanurus*.

The metacercariae show characteristic annulations and measure 0.49 mm. in length and 0.16 mm. in the greatest width. The oral sucker (0.036 mm. × 0.029 mm.) situated at the anterior end leads into a muscular pharynx and

1. van Uden, N. and Carmo Sousa, Lidia Do, *Jour. gen. Microbiol.*, 1957, **16**, 385.

2. Shifrine, M. and Phaff, H. J., *Mycologia*, 1956, **48**, 41.

two cæca which reach to the posterior end. The circular acetabulum (0.10 mm.) is more than twice as large as the oral sucker, situated at 0.11 mm. below the anterior end. The testes (0.025 mm. \times 0.057 mm.) are oval bodies arranged linearly in the posterior half of the body, with the ovary (0.025 mm. \times 0.043 mm.) posterior to them. The seminal vesicle is immediately pretesticular with the pars prostatica well developed. The vitellarium (0.046 mm. \times 0.071 mm.) is single, compact and reniform situated immediately behind the ovary. The excretory vesicle is Y-shaped, with a long median stem and long lateral canals containing granules, which unite dorsal to the pharynx.

The characters of the larva, such as the presence of cuticular plications, the size of the acetabulum being more than twice that of the oral sucker, the single compact vitellarium and the Y-shaped excretory vesicle with the anterior transverse vessel dorsal to the pharynx show that the metacercariae belong to the genus *Aphanurus* of the family Hemiuridae.

Dept. of Zoology,
Andhra University,
Waltair, March 2, 1961.

P. N. GANAPATI.
K. SHANTHAKUMARI.

1. Steuer, A., *J. Parasit.*, 1928, **15** (2), 115.
2. *Hall, M. C., *Smithson. Misc. Coll.* 1929, **81** (15), 1.
3. Lebour, M. V., *J. Mar. Biol. Ass.*, U.K., 1935, **20**, 371.
4. Hunninen, A. V. and Cable, R. M., *J. Parasit.*, 1943, **29** (1), 71.
5. Dollfus, R. Ph., *Vie et Milieu*, 1954, **5**, 565.
6. Chabaud, A. G. and Biguet, J., *Ann. Parasit. hum. Comp.*, 1955, **29** (5-6), 527.
7. Steuer, A., *Wiss. Ergebnisse der Deutschen Tiefsee Expedition*, 1932, **24**.
8. Marshall, S. M. and Orr, A. P., *The Biology of a Marine Copepod Calanus finmarchicus (Gunnerus)*, Edinburgh, Oliver and Boyd, 1955, pp 188.
9. Krishnaswamy, S., *J. Madras Univ.*, 1950, **20**, 75.
10. Sewell, R. B. S., *The John Murray Exped.* 1933-34, *Scientific Reports*, 1951, **9**, 346.
11. Yamaguti, S., *Systema helminthum* Interscience Pub. Inc., New York, 1958, **1**, Parts 1-2, 1575.

* Original not referred.

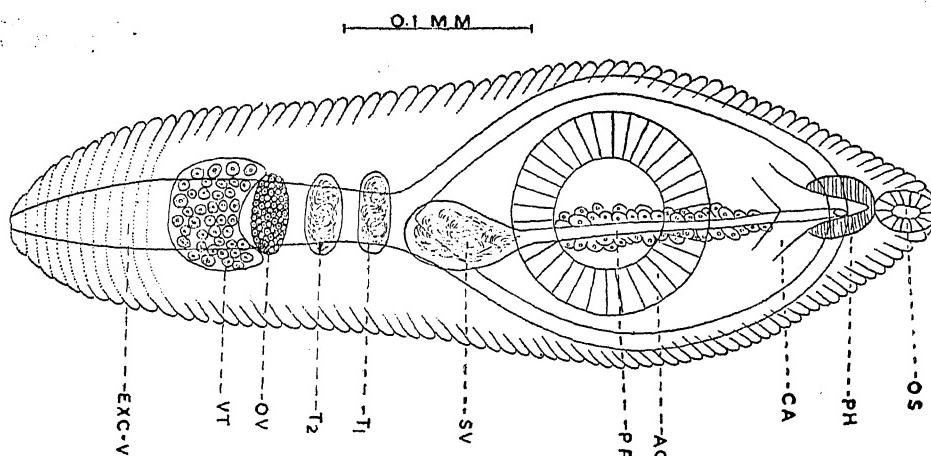


FIG. 1. Metacercaria of *Aphanurus* sp.: AC, Acetabulum; CA, Cæcum; EXC. V., Excretory vesicle; OS, Oral sucker; OV, Ovary; PH, Pharynx; PP, Pars prostatica; SV, Seminal vesicle; T₁, T₂, Testes; VT, Vitellarium.

It would appear that the copepodites and adults of *Acrocalanus gracilis* (Giesbrecht) form the natural intermediate hosts for a species of adult *Aphanurus* which has been found to occur frequently in *Sardinella gibbosa* (Bleeker) and *Sardinella fimbriata* (Cuvier and Valenciennes) which are common edible fishes off this coast.

One of us (K. S.) is indebted to the C.S.I.R. for the award of a Research Fellowship during the tenure of which the work was undertaken.

ON THE GROWTH OF ANTENNAE OF *GERRIS FLUVIORUM* F. (HEM., GERRIDIDAE)

In the course of studies on the development of *Gerris fluviorum* F. one of us (G. T. T.) noticed that the growth of the individual antennal segments occurs at a rate different from that of the antenna as a whole as well as that relative to one another.^{5,6} A quantitative study

of relative growth of the four antennal segments was therefore undertaken with a view to applying our data to the notation suggested by Huxley and Teissier.¹ The number of instars required for neanides of *Gerris fluviorum* F. to reach the adult stage is five.² Significant change in the lengths of antennal segments takes place during development and Table I gives the details of the increments of growth at each moult. The first two antennal segments are relatively short in the first neanidal instar and they form a progressively larger proportion of the total antennal length in the subsequent instars. Conversely, the remaining two segments are relatively long in the first instar and form a progressively smaller proportion of the total antennal length. Thus a change in proportion in the lengths of the antennal segments during the neanidal life of *G. fluviorum* F. is clearly demonstrated. We have followed Miller in using the term 'neanide' in preference to 'larva' or 'nymph'.³ For the sake of brevity, only the most essential calculations are included.

TABLE I

Lengths (mean of 15 individuals) of antennal segments in different instars of *G. fluviorum* F.
(in mm. \pm .03)

Instar	Antennal Segments				Total
	I	II	III	IV	
	y	y	y	y	x
1	.39	.31	.48	.90	2.08
2	.74	.43	.68	1.11	2.97
3	1.17	.71	.81	1.30	3.99
4	1.50	1.16	1.15	1.49	5.30
5	1.91	1.45	1.38	1.78	6.52
Adult	2.50	1.9	1.6	2.1	8.10

The recognised notation for the law of allometry has been expressed as $y = bx^a$ where y is the part; x is the standard or whole and a and b are constants. When $a > 1$ we have an instance of positive allometry; when $a < 1$ it is a case of negative allometry and when $a = 1$ the growth is isometric. Introducing logarithms, it can be written as $\log y = \log b + a \log x$ which assumes the form $Y = aX + B$ where $X = \log x$; $Y = \log y$ and $B = \log b$. The base of the logarithms can be 10 or e . Here we have taken the base as 10. The normal equations to determine the optimum values of a and B are:

$$a \sum X^2 + B \sum X = \sum XY \quad (1)$$

$$a \sum X + 6B = \sum Y \quad (2)$$

From the above data and adapting the standard method of the 'calculus of observations' the

constants a and b can be evaluated. Thus for the first segment we get $a = 1.33$ and $b = 0.16$. The equation describing the first segment is $y = 0.16 x^{1.33}$. The equation for the best-fitting line is $Y = 1.33 X - 0.7846$. Following the same procedure for the second segment we obtain $a = 1.4$ and $b = 0.10$ so that the equation is $y = 0.10 x^{1.4}$ and the equation for the best-fitting line is $Y = 1.4 X - 0.9986$. Similarly the normal equations to the third segment give $a = 0.46$ and $b = 0.0010$ so that the equation is $y = 0.0010 x^{0.46}$ and the best-fitting line is $Y = 0.46 X - 2.9864$. And the normal equations for the fourth segment give $a = .60$ and $b = 1.21$ so that the equation is $y = 1.21 x^{0.60}$ and the best fitting line is $Y = 0.60 X - 0.08$.

The employment of logarithms is of advantage in plotting the data in a graph since it makes the graph a straight line which otherwise would be a non-linear curve.² Fig. 1 gives the graph of the best-fitting straight lines which describe the growth of each segment.

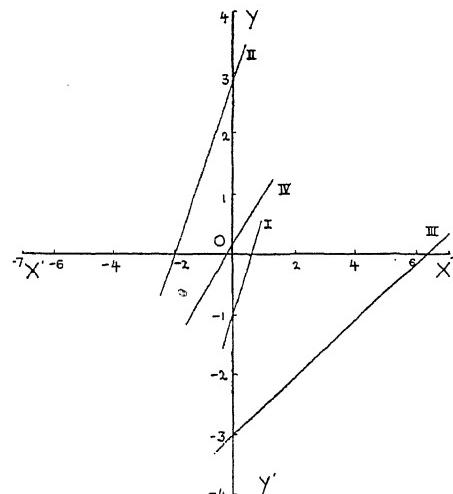


FIG. 1. Graphs of the best-fitting lines describing the growth of the four antennal segments of *Gerris fluviorum* F. Scale on X-axis $1'' = 2$. Scale on Y-axis $1'' = 1$.

It can be readily appreciated that the first two antennal segments show a positive allometry whereas the remaining two segments indicate a negatively allometric growth. Studies on the growth of other cuticular structures are currently under progress and a fuller discussion of the data will be published elsewhere.

It is a pleasure to acknowledge the facilities provided by the University of Poona. We are thankful to the Head of the Department of Zoology for encouragement.

University of Poona,
Ganeshkhind,
Poona-7, March 10, 1961.

G. T. TONAPI.
B. RAJA RAO.

1. Huxley, J. S. and Teissier, G., *Nature*, 1936, **137**, 780.
2. De Beer, G. R., In the *New Systematics*, 1940, London.
3. Miller, N. C. E., *The Biology of Heteroptera*, 1956, London.
4. Tonapi, G. T., *Ent. Mon. Mag.*, 1959, **35**, 29-31.
5. —, *Entomologist*, 1961 (In press).
6. —, Unpublished data.

A SIMPLE METHOD OF REDUCING VARIATIONS OF CURRENT DURING ELECTROPHORESIS

FOR electrophoretic separation of the proteins of the sheep serum, the apparatus of A. H. Thomas Company of U.S.A. (No. 4937-W. 5) and a "Sola" constant voltage transformer were used here. The veronal buffer used had a pH of 8.6 and ionic strength of 0.1. The applied voltage was 75 V. and duration of run 18 hours at the room temperature of about 25° C. The total current through four Whatman 3 M.M. paper strips, each $1\frac{1}{2}'' \times 12''$, was 4.5 m.a. at the start of the run, but towards the end increased to 6 to 7.5 m.a. Evaporation was excessive and records showed poor reproducibility. Keeping the cabinet in a low temperature incubator improved matters, but this was inconvenient. A constant current assembly was not available.

After a few trials with different values, a 0.1 Meg. potentiometer was used as a variable resistance in series with the paper strips. At a voltage of 275 V. the external resistance was adjusted to allow 5 m.a. of current to flow through the circuit. The change in the resistance of the paper strips had only a negligible effect now because of the high overall resistance. At the end of the run of 18 hours, the current increased by only 0.25 m.a. Reproducibility was excellent.

Dept. of Physiology, K. N. GOVINDAN NAYAR,
Madras Veterinary College,
Madras-7, March 8, 1961.

A HETEROPOLYSACCHARIDE FROM *PASTEURELLA MULTOCIDA*, ROBERTS' TYPE I

LITTLE is known of the carbohydrates of *Pasteurella multocida*, Roberts' type I, the causal organism of haemorrhagic septicæmia in cattle and buffaloes. We have examined the strain (P_{52}) of *P. multocida*, used in this laboratory for the preparation of an oil-adjuvant vaccine¹

with the object of obtaining material which might be of value in immunological studies. Various methods of extraction like heating in a water-bath at 56° C. for 1 to 6 hours,^{2,3,5,6} and treatment with different solvents like phenol^{4,5} and trichlorotrifluoroethane⁵ were tried by earlier workers but this paper describes physico-chemical immunobiological characterisation of a polysaccharide that was recovered by fractional precipitation with ethanol at 68% (V/V) concentration from extracts prepared from acetone-dried yeast-extract agar-grown cells of *P. multocida* after hydrolysis with N/4 NaOH for 5 to 6 hours at 56° C.

The materials were white powders, easily soluble in water, forming viscous solution, slightly acidic in reaction and contained 1.8 to 2.0% nitrogen and traces of phosphorus (< 0.1%). They reacted negatively in the biuret, Millon and ninhydrin tests. They gave a positive anthrone reaction for carbohydrates and did not show the presence of any free sugar or nucleic acid.

When the samples of polysaccharides were hydrolysed in 0.5 N H_2SO_4 and the hydrolysates chromatographed in four solvent systems, galactose and ribose were the only sugars detected. Precipitation-inhibition tests substantiated their presence. The identity of galactose was confirmed by the preparation of d-methylphenylhydrazone. No evidence for the presence of amino-sugars, uronic acids or aldoheptoses could be obtained by the application of colorimetric tests.⁷⁻⁹ The washed suspensions of cells of *P. multocida* were found to contain approximately 2.5 to 3% of their dry weight as carbohydrate when analysed by the anthrone procedure of Trevelyan and Harrison,¹⁰ using galactose as the standard. These values closely agreed with those reported by Carter and Annau,² Briefman and Yaw³ and Dhanda⁵ for extracts obtained by different techniques.

The polysaccharide was not toxic nor pyrogenic when injected into mice and rabbits. It could not act either as a preparing or as shocking reagent in the elicitation of generalised Schwartzman reaction in rabbits. It gave positive precipitation reactions (1: 150,000 to 1: 500,000) with *P. multocida* type I antiserum, sensitised erythrocytes (the optimal concentration being 500 micrograms/ml.) to agglutination by the antisera and to lysis in the additional presence of complement. It itself inhibited the agglutination and lysis of sensitised erythrocytes by antisera (12.5 micrograms/ml.). It, thus, possessed the properties of a complex hapten. No antibody formation could be detected following

injections of the polysaccharide into rabbits but high titre antisera could be produced by administration of antigen-coated erythrocytes.

On diffusion against type I antiserum, the polysaccharide gave rise to a single line of precipitation and proved to be heat-stable but sensitive to the action of potassium periodate.

The polysaccharide was not immunogenic in mice, rabbits and cattle and pure polysaccharide antisera failed to exhibit any murine passive protective activity. However, when tested on the lines of Rowley,¹¹ it stimulated non-specific immunity to an extent approaching that caused by *Escherichia coli* 2038. It was found to possess antiphagocytic and virulence-enhancing activity at low concentrations.

The polysaccharide preparations absorbed very little of the homologous mouse-protective activity from a rabbit type I whole-cell antiserum. However, intra-abdominal injection of 30 micrograms of these preparations diminished the immune response of mice to subsequent injections of an effective type I vaccine, thus manifesting its immunological activity by the interference effect and suggesting degradation during purification.

Synthetic polyglucoses which contain a variety of linkages with 1-4, 1-6 and 1-4-6 predominant and a number of glycogens which contain 1-4-6 branching points showed no cross-reaction with the pure polysaccharide antiserum.

The polysaccharide failed to inhibit haemagglutination of fowl erythrocytes by Newcastle disease virus or block the specific blood group antigens tested so far.

The relationship of this polysaccharide extracted by a modification of the alkaline hydrolysis method of Thomas and Mennie¹² to the capsular polysaccharides (fraction IV) obtained by the senior author⁵ and other workers^{2,3,4,6} is being investigated intensively in the laboratory at Mukteswar.

College of Vet. Sci.,
U.P. Agri. University,
P.O. Pantnagar, Dist.
Nainital, April 29, 1961.

M. R. DHANDA.
PREM PRAKASH.
P. C. SEKARIAH.*

* Division of Pathology and Bacteriology, Indian Veterinary Research Institute, Mukteswar-Kumaon, U.P.

- Dhanda, M. R., Das, M. S., Lall, J. M. and Seth, R. N., *Ind. J. Vet. Sci. and Anim. Husb.*, 1956, **26**, 273.
- Carter, G. R. and Annau, E., *Amer. J. Vet. Res.*, 1953, **14**, 475.
- Briefman, L. and Yaw, K. E., *J. Bact.*, 1958, **75**, 236.
- MacLennan, A. P. and Rondle, C. J. M., *Nature*, London, 1957, **180**, 1045.

- Dhanda, M. R., *Ind. Vet. J.*, 1959, **36**, 6.
- Prem Prakash and Dhanda, M. R., Unpublished data, 1969.
- Boas, N. F., *J. Biol. Chem.*, 1953, **204**, 553.
- Dische, Z., *Ibid.*, 1947, **167**, 189.
- Davies, D. A. L., *Biochem. J.*, 1957, **67**, 253.
- Trevelyan, W. E. and Harrison, J. S., *Ibid.*, 1952, **50**, 298.
- Rowley, D., *Brit. J. Exp. Path.*, 1956, **37**, 223.
- Thomas, J. C. and Mennie, A. T., *Lancet*, 1950, **2**, 248.

A NOTE ON TERMITES (INSECTA: ISOPTERA) INFESTING SUGARCANE CROP IN RAJASTHAN

A NOTE on an infestation of termites around Udaipur in Rajasthan was recently published by the author,¹ in which were reported 4 different species, viz., *Odontotermes (O.) obesus* Rambur, and *Odontotermes (Odontotermes) obesus f. gurdaspurensis* Holmgren, *Odontotermes (Odontotermes) bangalorensis* Holmgren [syn. *Odontotermes (Cyclotermes) bengalensis* Holmgren], *Microtermes anandi* Holmgren (syn. *Microtermes obesi* Holmgren) and *Trinervitermes biformis* (Wasmann) as infesting cultivated fields, orchards and forest trees. The present observations refer to widespread damage caused to sugarcane (*Saccharum officinarum* Linnaeus) cultivation by various species of termites in the districts of Udaipur, Chittor and Sawai Madhopur in the State of Rajasthan.



FIG. 1. Showing termite (white ants) damage in sugarcane. (a) Plant showing excavated tunnel at the base above-ground. (b) Thin outer rind of the damaged setts has been stretched out to expose the soil within. (c) Clod of soil within the damaged sett. (c') Underground setts cut open to show the excavated tunnels compactly filled with soil.

Two species, namely, *Odontotermes (Odontotermes) obesus* Rambur and *Microtermes anandi* Holmgren (Family: Termitidae; Subfamily:

Macrotermitinæ) have been commonly observed by the writer as major pests of sugarcane in all these Districts. Both species have been observed attacking mostly the underground setts, independently and sometimes simultaneously. Generally the damage starts through the cut ends and gradually the entire pith is eaten up. The tunnels excavated thus are compactly filled up with moist soil leaving only the live galleries within, but the outer rind is always spared and left intact as a thin covering (Fig. 1). The growing shoots at their base show a similar damage. Consequently the plants exhibit a stunted growth and ultimately dry up. Generally the attack is more serious within the first 4 or 5 months of sowing. At Bhupalsagar (District : Chittor) and in the adjoining area the pest has been incessantly attacking the sugarcane crops, and the damage during March, 1960 was so severe in certain plots that the entire crop in these had to be destroyed to check the infestation from spreading.

Another species, *Odontotermes (Odontotermes) brunneus* (Hagen), so far not recorded from Rajasthan, was also collected from mounds adjacent to sugarcane fields at Bhupalsagar, but no damage to the crop was observed.

Control trials conducted so far have failed to destroy the pest and have given no conclusive results, probably, because of their peculiar capacity for avoiding the treated plots.

My sincere thanks are due to Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, for identification of the specimens and Shri Y. Ramchandra Rao for going through the note and making a few kind suggestions. I am also very grateful to Dr. A. Rathore, Principal, Rajasthan College of Agriculture, Udaipur, for laboratory facilities.

K. S. KUSHWAHA.

Dept. of Zoology & Entomology,
Rajasthan College of Agriculture,
Udaipur (Rajasthan),
January 25, 1961.

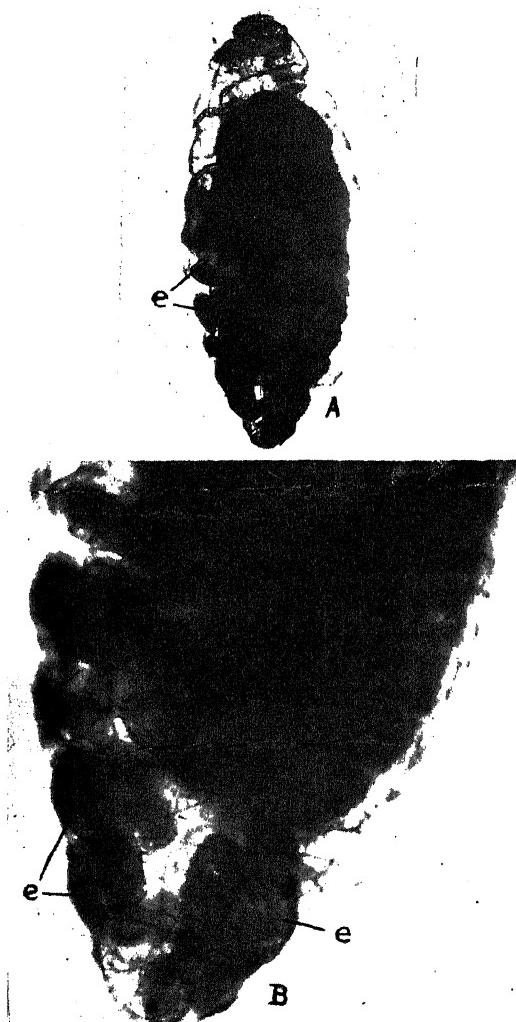
1. Kushwaha, K. S., *Sci. and Cult.*, 1960, 26, 39.

AN UNUSUAL MODE OF EGG-LAYING IN *TROGODERMA GRANARIUM* EVERTS (DERMESTIDAE: COLEOPTERA), A PEST OF STORED CEREALS

Trogoderma granarium Everts is a serious pest of stored cereals in India. Recently, it has gained entry into California and has established itself there.¹ Although the pest had been mentioned in Indian entomological literature as early as in 1894² and its biology extensively

studied,³⁻⁵ the workers have apparently failed to make a very interesting and important observation about the egg deposition.

During the present investigation, when the insects were being reared at $33 \pm 1^\circ\text{C}$, eggs were found in clusters at the caudal end in between the last larval exuvium and the pupal skin (Figs. A and B) before the emergence of adults. Normally the eggs are laid among the



Figs. A-B. A. Matured pupa enclosed in last larval exuvium, with the eggs (e). B. The caudal end highly magnified, showing the eggs (e) in between the last larval exuvium and pupal skin.

grain.⁴ The number of eggs in each instance, in the present case, varied from 15 to 45. Their viability was studied and about 80% of the eggs were found viable. The sex ratio of the adults

from such eggs was also studied. No significant difference was, however, observed when compared with normal sex ratio. As to the source of these eggs, it was first thought to be due to parthenogenesis, but when the clean larvae free from any extraneous material were placed singly in glass specimen tubes (2.5" x 0.5") and allowed to come up to the adult stage, no egg was noticed. When matured pupae formed from such larvae were placed together with the adults from the culture, the eggs were found present in some cases in between the last larval exuvium and the pupal skin. This was more prominent under conditions of crowding.

It is possible that *T. granarium* in this way probably exhibits parental care of Brutus-sorge type, i.e., providing shelter for the development of eggs against natural enemies.

The present observation has an important bearing on the control of this serious pest. Sometimes in storage godowns the presence of mere exuviae is not at all taken seriously. The concealed eggs in between these last larval exuviae and the pupal skins may then prove to be a constant source of infestation which more often than not escape the notice of technical staff undertaking control measures.

The authors are thankful to Dr. E. S. Narayanan, Head of the Division, for his keen interest in these investigations.

Division of Entomology, SNEHAMOY CHATTEPJEE,
Indian Agricultural Research Institute, PRAKASH SARUP,

Research Institute,
New Delhi-12, January 3, 1961.

1. Lindgren, D. L., Vincent, L. E. and Krohne, H. E., *Helgol. Wiss. Meeresunters.*, 1955, **24** (1), 1.
2. Barnes, I. H. and Grove, A. J., *India Dept. Agric. Mem.*, 1916, **4** (6), 165.
3. Hinton, H. F., *A Monograph of the Beetles Associated with Stereot Products*, British Museum, London, 1945, **1**, 443.
4. Pruthi, H. S. and Singh, M., *Indian J. Agric. Sci.*, 1950, **18** (4), 1 (Special Number).
5. Lindgren, D. L. and Vincent, L. E., *J. econ. Ent.*, 1959, **52** (2), 312.

TWO NEW RECORDS IN SOIL FUNGI

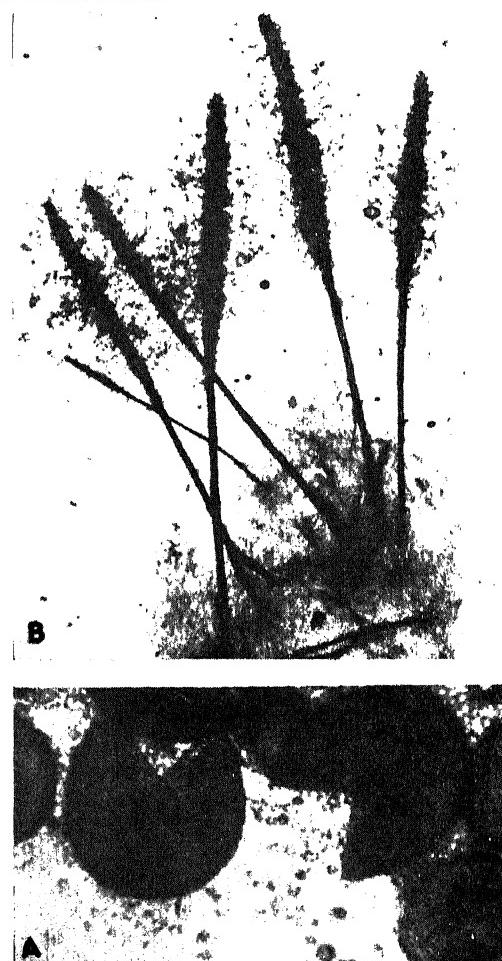
Two species of fungi, *Thielavia sepedonium* Emmons, and *Trichurus spiralis* Hasselbring, hitherto, unrecorded from soil, have been isolated from soil samples collected from various localities in India listed in Table I.

Thielavia sepedonium Emmons (Photo A, Figs. 1-9) conforms in general to its original description,¹ except that the strain encountered here occasionally produces two-celled and at

TABLE I
Locality

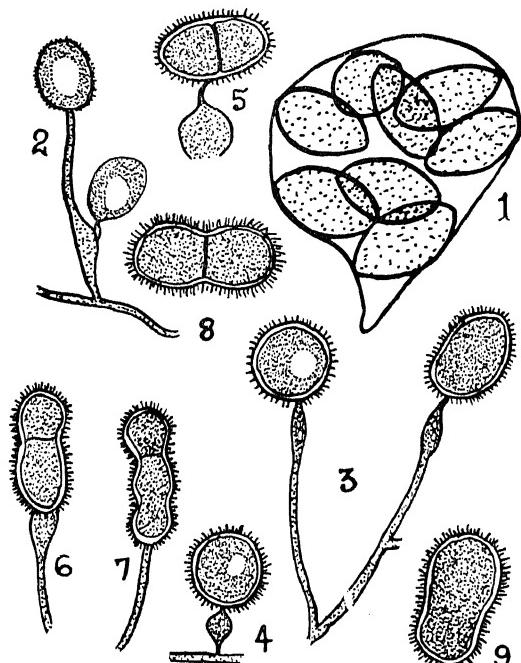
Fungus	Darjeeling pH 6.5	Hardoi pH 7.5-9.0	Kanpur pH 7.0-9.0	Lucknow pH 6.0-9.5	Rae Beri pH 6.8-9.0
<i>Thielavia sepedonium</i> Emmons	-	+	+	+	+
<i>Trichurus spiralis</i> Hasselbring	+	-	+	+	-

times irregularly-shaped conidia. This form has been isolated from about 80% of the soil samples examined. A living culture has been deposited in the Commonwealth Mycological Institute, Kew, England, under reference No. I.M.I. 82620.



PHOTOS A-B. A. Cleistothecia, conidia and ascospores of *Thielavia sepedonium* Emmons, $\times 172$. B. Coremia of *Trichurus spiralis* Hasselbring, $\times 34$.

Trichurus spiralis Hasselbring (Photo B) is characterised by the presence of stalked coremia bearing penicilli on long threads and long, tortuous, sterile, septate hair, which are brown near the base, becoming hyaline at the tips, giving the fructification a characteristic flocculent appearance.² This form has been isolated from about 2% of the soil samples examined. A living culture has been deposited in the Commonwealth Mycological Institute, Kew, England, under reference No. I.M.I. 82621.



Figs. 1-9. *Thlicavia sepedonium* Emmons. Fig. 1. Ascus. Fig. 2. A conidiophore with young conidia. Figs. 3, 4. Conidiophores with mature conidia. Fig. 5. A conidiophore with two-celled conidium. Figs. 6, 7. Conidiophores with two-celled irregularly-shaped conidia. Fig. 8. A two-celled conidium. Fig. 9. An irregularly-shaped conidium. All figures, $\times 1,160$.

We are grateful to the Director, Commonwealth Mycological Institute, Kew, England, for his help in the identification of the forms described. Thanks are also due to the Ministry of Scientific and Cultural Affairs, Government of India, for the grant of a Research Training Scholarship, and to the Council of Scientific and Industrial Research, New Delhi, for the award of a Research Fellowship to the junior authors during the tenure of which this work has been done.

Dept. of Botany,
Lucknow University,
Lucknow (India),
December 22, 1960.

J. N. RAI.
K. G. MUKERJI.
J. P. TEWARI.

1. Emmons, C. W., *Bull. Torrey Bot. Club*, 1932, 59, 415.
2. Hasselbring, H., *Bot. Gaz.*, 1900, 29, 312.

PACHYTENE ANALYSIS IN *MELILOTUS SEGETALIS* SCHULZ.

KARYOMORPHOLOGICAL studies in species with small chromosomes are most profitably undertaken by the analysis of the pachytene stage in PMCs. This statement is amply substantiated by the studies on *Zea*, *Lycopersicon*, *Plantago*, *Sorghum*, *Oryza* and several other materials where the karyological study of somatic metaphases in root tips is very difficult. In the genus *Melilotus*, pachytene analysis was initiated by Shastry, Smith and Cooper (1960) by the analysis of the *F₁* hybrid, *M. messanensis* \times *M. segetalis*. Later, Shastry and Cooper (1961) investigated the karyomorphology of *M. messanensis* at pachytene. In the present note, the pachytene analysis of *M. segetalis*, compared to that of *M. messanensis*, is reported. The techniques employed are similar to those described by Shastry *et al.* (1960).

Pachytene bivalents of *M. segetalis*, like those of *M. messanensis*, are more or less uniformly stained with no distinct macrochromosomes, but with some darkly-stained heterochromatic regions (chromosomes 2, 3 and 6). While the full complement of chromosomes was analysed in 5 PMCs only, 4-5 bivalents were analysed in 20 cells. The cell-to-cell variation in lengths of bivalents was 4-6 μ , which is negligible. Individual chromosomes were identified by length, arm ratio and heterochromatic pattern and were numbered in the descending order of their length.

Figures 1 and 2 show PMCs in which the entire complement is analyzable. The lengths and arm ratios of the bivalents of the species, *M. segetalis*, as compared to those of *M. messanensis* (Shastry and Cooper, 1961) are given in Table I.

It will be seen from Table I that the individual bivalents of both the species are more or less comparable in their total lengths and arm ratios. The differences were observed in chromosomes 2, 7 and 8 with regard to arm ratios and 1, 2 and 8 in total length. Such minute differences could not have been detected if the karyotype was analyzed at somatic metaphase. The karyotypes of both the species

TABLE I
Data on length and arm ratios of bivalents of *M. segetalis* in comparison to those of
M. messanensis
(Data on *M. messanensis* taken from Shastri and Cooper—in press)

No. of chromo- some pair	Length in Microns		Long arm <i>M. messan-</i> <i>nensis</i>	Short arm <i>M. segetalis</i>	Total	<i>M. messan-</i> <i>nensis</i>	<i>M. segetalis</i>	Arm Ratio <i>M. messan-</i> <i>nensis</i>	<i>M. messan-</i> <i>nensis</i> : <i>M. segetalis</i>
	Short	Arm							
	<i>M. messan-</i> <i>nensis</i>	<i>M. segetalis</i>							
1	28.8	29.8	39.0	41.0	67.8	73.8	67.8	0.74	0.68
2	22.8	18.7	26.4	41.2	49.2	59.9	49.2	0.86	0.45
3	12.0	10.7	22.8	23.5	34.8	39.1	34.8	0.53	0.67
4	1.6	1.8	19.2	19.9	34.8	32.7	34.8	0.81	0.65
5	9.6	8.1	20.2	23.8	27.0	27.3	27.0	0.38	0.34
6	8.4	10.2	18.6	17.1	18.0	22.7	18.0	0.45	0.60
7	3.6	3.8	7.8	14.4	12.0	18.9	12.0	0.25	0.52
8	4.2	7.9	—	—	—	—	—	0.54	0.74



Figs. 1-2
fall under group 2-c of Stubbins' (1958) classi-
fication

The authors are grateful to Dr. B. P. Pati, Director, and Dr. A. B. Jethi, Dean, for providing facilities and to Prof. W. K. Smith, University of Wisconsin, for making available the seeds of *M. messanensis*.

D. R. RANGA RAO,
S. V. S. SHASTRI,

Division of Botany,
Indian Agricultural
Research Institute,
New Delhi-12, February 14, 1961.

- Shastri, S. V. S., Smith, W. K. and Cooper, D. Amer. Jour. Bot., 1960, **46**, 613.
- and Cooper, D. C., Jour. Heredity, 1961 (in press).
- Stubbins, G. L. Jr., Cold Spring Harb. Symp. On Biol., 1958, **23**, 365.

FLINT × DENT MAIZE HYBRIDS INCREASED YIELDS

IN the early stages of research on the development of hybrid maize in India mainly in the development of parental inbred lines hybrids. As a result of these research three-way cross (15 x 1.5)S 23,¹ and a cross hybrid, Punjab Hybrid No. 1, evolved and put into limited commerce respectively. These hybrids yielded up to 20% more than the best open-pollinated varieties under cultivation. While such had been made, the increased yields as high as those obtained from hybrids in the U.S.A., Mexico and Colombia,² work in the U.S.A. has shown that hybrids produced from inbred lines of diverse origin give considerably more yield produced by crossing related lines.³

Researches were initiated at the Indian Cultural Research Institute, New Delhi to study the performance of genetic inbred lines in hybrid combinations to evaluate the utility of exotic germplasm in the Indian hybrid maize programme.

experimental procedures were employed to study this aspect of the problem.

I. Eleven flint inbred lines, developed from Indian open-pollinated varieties and possessing high general combining ability, were taken. One such line, PB 4, originating from a Bihar open-pollinated variety, was used as the tester parent and crossed to four other lines from Bihar germ plasm (group A). The tester line was also crossed to seven other inbred lines originating from Indian germ plasm sources other than Bihar (group B). Lastly the tester line was crossed to four dent lines originating from U.S.A. (group C). The lines from U.S.A. were parents of established maize hybrids in commercial production in that country. These three groups of single crosses, along with the local open-pollinated variety, KT 41, as check, were tested in a replicated yield trial.

The average yield of the single crosses in group A was 2,586 lb. per acre, which was about 24% more than the local check variety, KT 41. The group B yielded on an average 2,984 lb. per acre which was 43% more than the local variety. The difference between the two groups A and B was significant and in favour of group B. Group C, comprising the most diverse germ plasm combinations, yielded 3,306 lb. per acre, which was 58% more than the check KT 41. This group of hybrids significantly outyielded those in groups A and B.

Group C on an average took 54 days to silk as against 56, 55 and 50 days to silk for the groups A, B, and the check variety respectively. Thus group C was superior in yield to the two other groups and the local variety and had about the same maturity as the local check.

II. The second procedure of testing the effect of genetic diversity was as follows:—

An Indian open-pollinated variety PY 2, adapted to Delhi area, was used as the tester. It was crossed to 24 inbred lines developed from the Indian open-pollinated varieties (group X) and 20 dent inbred lines from U.S.A. (group Y). Inbred lines in group Y represented the genetically diverse germ plasm in this experiment. The two sets of top crosses, along with the tester parent PY 2, and the recommended local open-pollinated variety KT 41, were studied in a replicated randomized trial.

The average yield of the top crosses in group X was 3,382 lb. per acre and group Y 4,093 lb. per acre; the tester parent PY 2 yielded 2,422 lb. per acre. Groups X and Y were significantly superior to the tester by 42 and 69% respectively. Moreover, group Y significantly outyielded X by 21%.

These studies clearly indicated that dent inbred lines, representing more diverse genetic source than Indian lines, gave superior performance in combinations with Indian germ plasm than Indian \times Indian combinations.

Division of Botany, N. L. DHAWAN.
Indian Agri. Res. Institute, JOGINDER SINGH.
New Delhi-12, April 14, 1961.

1. Chavan, V. M., Kelkar, S. G. and Bidari, P. G., *Curr. Sci.*, 1950, **19**, 156.
2. Negi, L. S. and Bahans, K. S., *Indian Fmg.*, 1957, **7**, 32.
3. Sprague, E. W., Dhawan, N. L. and House, L. R., *Curr. Sci.*, 1960, **29**, 295.
4. Andres, J. M. and Bascianni, P. C., *Inst. Genet. Fac. Agron. Vet.*, B. Aires, 1940, **1**, 20; (*P.B.A.*, **12**, 146).
5. Johnson, I. J. and Hayes, H. K., *J. Amer. Soc. Agron.*, 1940, **32**, 479.
6. Griffing, B. and Lindstrom, E. W., *Agron. J.*, 1954, **46**, 545.

EFFECT OF FLOWER SUPPRESSION AND GRAFTING ON NICOTINE CONTENT IN TOBACCO

Nicotiana tabacum is normally determinate in its growth and does not need any specific day-length for flowering. A recessive mutation termed "mammoth" characterised by indeterminate growth and short-day requirement for flowering has been isolated in *N. tabacum*.¹ This mutation has not been found in *N. rustica* but has been transferred to it from *N. tabacum* by hybridization and back-crossing.¹ The "mammoth" gene behaves as a temperature preceptor for flowering in a *N. rustica* genotype.² When grown at New Delhi during the summer months, mammoth plants do not flower. In order to ascertain whether genetic suppression of flowering has any effect on nicotine content, sun-dried samples of leaves (without petioles) from normal and "mammoth" plants derived from *rustica-tabacum* crosses were subjected to nicotine estimation by the spectrophotometric method.³ Estimations were also carried out in one variety each of *N. tabacum* and *N. rustica* and in reciprocal grafts between them (in the grafts, the samples were taken from the scion). The *rustica-tabacum* hybrid derivatives segregating for the "mammoth" character had been obtained from Dr. H. H. Smith of the University of Cornell, United States. The parent varieties used in this cross were unfortunately not available. Ten samples were taken in each case and the average nicotine content in the different material is given in Table I.

TABLE I

Sl. No.	Material	Average nicotine content (%)
1	<i>N. rustica</i> var. N.P. 220	1.56
2	<i>N. tabacum</i> var. Kwang	1.28
3	<i>N. rustica</i> \times <i>N. tabacum</i> derivatives	
	(a) Normal	3.12
	(b) Mammoth	4.55
4	N.P. 220 on Kwang root stock	1.37
5	Kwang on N.P. 220 root stock	2.23

The data indicate that first, suppression of flowering increases nicotine content in tobacco and secondly the root stock influences the nicotine content of the scion. Thus, the *rustica*-*tabacum* "mammoths" have higher nicotine content in addition to being superior to the normal plants both in the number and size of leaves.

I am indebted to Dr. M. S. Swaminathan, Cytogeneticist, for suggesting this study and to Dr. C. Dakshinamurti, Senior Physicist, for advice and help in the spectrophotometric estimation of nicotine content.

Division of Botany, K. A. PATEL.
Indian Agricultural Research Institute,
New Delhi-12, February 27, 1961.

- Smith, H. H., *J. Heredity*, 1950, **41**, 199.
- Murty, B. R. and Swaminathan, M. S., *Euphytica*, 1957, **6**, 227.
- Ramamurthy, B., Chatterjee, B. C., Dakshinamurti, C. and Gulati, K. C., *Nature*, 1952, **169**, 112.

VARIATION AMONG RICE VARIETIES IN REGARD TO GERMINATION UNDER SUBMERSION, AND HEAT STABILITY OF CHLOROPHYLL*

TWENTY varieties of rice (U.S.A.) were germinated in a 0.30 molar sucrose solution and 12 of these were later grouped into three classes : (1) drought resistant; (2) drought susceptible and (3) intermediate, based on their wilting behaviour in pot culture in the green house, by cutting off water-supply after 21 days' growth. Four varieties in each of the groups 1 and 2 above were further tested for underwater germination and coleoptile growth, and three varieties for heat stability of chlorophyll, modifying the method followed by Kaloyereas (1958) for pine varieties.

For under-water germination test, seeds were taken one month after harvest and two seeds in each variety were placed into a test-tube

15 cm. long and 1.5 cm. in diameter and water maintained at a depth of 8 cm. The length of coleoptile was measured on the fifth day. For chlorophyll test, leaves from 20 days' old seedlings and weighing 2 gm. in each variety were heated in water-bath at $56 \pm 1^\circ\text{C}$. with 50 ml. of distilled water for one hour and 30 minutes. The leaves were then taken out and ground with 100 ml. of 80% acetone solution in water in a Waring blender for two minutes, the contents filtered over glass wool and tested for light absorption in a Klett photoelectric colorimeter using a No. 66 red filter. The data are presented in Tables I and II.

TABLE I
Under-water germination—Length of coleoptile
in cm. (Average of six measurements)

Group (1) Varieties	Group (2) Varieties
Rex x Red .. 2.88	C.I. 600I .. 1.05
Zenith .. 2.88	Early Prolific .. 1.75
Fortuna .. 2.90	Blue Rose .. 1.70
Blue Bonnet .. 3.25	Lacrosse .. 1.28
Average .. 2.98	Average .. 1.45

TABLE II
Colour readings obtained in chlorophyll extracts
(Average of two readings)

Group (1)	Group (2)
Rexoro .. 48.00	Early Prolific .. 98.25
Zenith .. 64.75	Blue Rose .. 99.75
Fortuna .. 48.50	Nato .. 96.00
Average .. 53.75	Average .. 98.00

The capacity of certain rice varieties for rapid germination and growth under submersion, as also their chlorophyll stability, would appear to be directly related to their resistance to drought in the initial stages of growth. Whether these indicate only a general type of resistance rather than a specific resistance to drought will be determined by undertaking more intensive studies with Indian varieties.

Rice Section,
Central Farm,
Mannuthy, Trichur, February 22, 1961.

* Summarized from a Thesis submitted for the M.S. Degree of the Louisiana State University (U.S.A.) in January 1961. Investigations were carried out at the University Botany Laboratories, at Baton Rouge and at the Rice Experiment Station, Crowley.

1. Kaloyereas, S. A., "A new method of determining drought resistance," *Plant Physiol.*, 1958, **33**, 232.

REVIEWS

Theory of Differential Equations. By Andrew Russell Forsyth. Six volumes bound as three. (Dover Publications, Inc., New York). Price for the set \$ 15.00.

The nineteenth century witnessed remarkable strides in pure mathematics and the theory of differential equations was the playground of some of the eminent mathematicians in the history of mathematics like Gauss, Hamilton, Jacobi, Cauchy, Lie, etc. In a monumental work that took over fifteen years to complete, Forsyth brought forth in six volumes every important development in the theory of differential equations that took place before the first decade of the present century. Forsyth himself has made several outstanding contributions to the subject and these volumes which cover over 2,500 pages represent one of the most comprehensive treatment of differential equations ever written. The publishers of the Dover series have now rendered a valuable service by reprinting these books which were out of print for a long time and bringing them in the form of three volumes that are beautifully bound and easy to handle.

Volumes I and II deal almost entirely with the functional character of the solutions of the ordinary differential equations, and give a good exposition of exact equations and Pfaff's problem. Volume III and IV deal with linear and non-linear equations, and Volumes V and VI cover the developments in the field of partial differential equations.

V.

A Treatise on the Analytical Dynamics of Particles and Rigid Bodies. By E. T. Whittaker. (Cambridge University Press, London, N.W. 1), 1960. Pp. xiv + 456. Price 35 sh.

The present paper-bound edition is a reprint of the fourth edition that was released in the year 1937. Whittaker's work has been so popular amongst applied mathematicians and theoretical physicists that a detailed review of the contents of the book seems hardly to be necessary. The general opinion of the book is reflected in the following statement from a review on the book that appeared in the *Mathematical Gazette*. "It has become the standard work on the topics with which it deals". The present edition will be warmly welcomed by all mathematicians, physicists and engineers.

V.

Statistical Thermodynamics. By Erwin Schrödinger. (Cambridge University Press, London, N.W. 1), 1960. Pp. 95. Price 8 sh. 6 d.

The book is a collection of the lectures delivered by Schrödinger at the School of Theoretical Physics, Dublin Institute, for advanced studies. The object of this course of seminar lectures is, in Professor Schrödinger's words, 'to develop briefly one simple unified standard method, capable of dealing, without changing the fundamental attitude, with all cases (classical, quantum, Bose-Einstein, Fermi-Dirac, etc.) and with every new problem that may arise. The interest is focused on the general procedure, and examples are dealt with as illustrations thereof. It is not a first introduction for newcomers to the subject, but rather a 'repetitorium'. The treatment of those topics which are to be found in every one of a hundred text-books is severely condensed, on the other hand, vital points which are usually passed over in all but the large monographs are dealt with at greater length.

The student's edition will be warmly welcomed by all physicists.

V.

The Theory of Optics. By Paul Drude. Translated from the German by C. Riborff Mann and Robert A. Millikan. (Dover Publications, Inc., New York), 1959. Pp. xxi + 564. Paper-bound, Price \$ 2.45.

As in literature so in science certain classics have an abiding value; the book under review belongs to this category. The appearance of Drude's treatise in the cheap paperback edition will be a great boon to students in India, especially as most modern books on the subject still compare unfavourably with it, as regards clarity of presentation.

S. P.

Physics of the Atom. By M. R. Wehr and J. A. Richards, Jr. (Addison-Wesley Publishing Co., Reading, Mass., U.S.A.), 1960. Pp. xii + 420. Price \$ 6.50.

This book presents an ideal introduction to modern physics and can be recommended to graduate students of Physics in Indian Universities. The twelve chapters of the book deal with the following main topics: Atomic views of matter, electricity, radiation, and solids; Rutherford-Bohr model of the atom; Relativity;

X-rays; Waves and corpuscles; Natural and artificial radioactivity, nuclear reactions and nuclear energy; Cosmic radiation and fundamental particles.

The topics have been chosen in a logical sequence, and in their presentation and development a chronological order has been followed. The special feature of the book is the informal style which the authors have used in writing. It reads like an across-the-table-talk (with a writing tablet in front to explain and drive home the point) between the teacher and the student, interspersed with many apt and illuminating analogies. The students while reading the book will experience no difficulty in understanding the new concepts involved in the growth of the subject to its present status. He will only be stimulated to go in for further detailed reading. This text-book "bridges the gap between classical physics and the new frontier of physical investigations". A chronology of the atomic view of Nature, and a list of Nobel Prize winners in Physics and Chemistry are given at the end of the book.

A. S. G.

Reactor Handbook (Second Edition), Vol. I—Materials. Edited by C. R. Tipton, Jr. (Interscience Publishers, New York, London), 1960. Pp. 1223. Price \$36.50.

This is the second edition of the *Reactor Handbook* prepared under contract with the United States Atomic Energy Commission. The first edition was published in 1955, and comprised of three volumes of total number of pages about 2,500. Those who have been using the first edition will have realised the indispensability of the volume; as a reference book on the subject and at the same time will be wishing for the publication of a new edition in which will be included all the latest developments that have taken place in Reactor Science and Technology. During the five years the growth in this field has been dramatic as will be clear not only from the, literally, thousands of publications but also from the number of international conferences and scientific meetings on atomic energy and allied subjects which have been held during the intervening period, the proceedings of many of which have come out in print. With such a large amount of bewildering data available the bringing out of a Handbook is itself a tremendous task. Add to this there is the difficulty that in a complex and ever changing field as the present one, many of the information compiled today may soon become out-

of date. Yet not only is a source-book on Reactor science a necessity, but it should be seen also that this information is rendered up to date as far as possible. In this context the Editors, the Review Board and the hundreds of contributors who will be making it possible for the second and expanded edition of the *Reactor Handbook* comprising of four volumes and a projected 3,500 pages to be brought out deserve the gratitude of all people connected with Reactor Engineering and Technology.

The volume under review is the first of the four volumes in the series and deals with *Materials*. The other volumes to be issued will be on *Fuel Reprocessing, Physics and Shielding*, and *Engineering* respectively.

The coverage in the present volume on Materials has been extended beyond that of the first edition to include liquids and gases, besides solids, and information on irradiation behaviour. The contents have been planned in a most rational way and the reactor materials have been taken up in the order of their functional utilization within the reactor. Thus the Fuel materials come first, followed by Cladding and Structural Materials, the Control Materials, the Moderator Materials, the Coolant Materials and, finally, the Shielding Materials.

The basic materials for reactor fuels are, of course, uranium, thorium and plutonium. But as they are totally inadequate for most reactor use, it is necessary to develop materials that contain them but have much different properties and have to fulfil stringent conditions. In the section on Fuel Materials there are separate chapters for uranium, thorium and plutonium, and their respective alloys. Each chapter deals with the preparation (or separation) of the fuel concerned, the heat treatment, the properties both physical and mechanical, corrosion effect and effect of irradiation. There is a chapter on ceramic or non-metallic fuels such as UO_2 , UC, or UC_2 which are used either alone or in combination with other ceramics, as fuel element cores or as fuel grains dispersed in graphite, BeO or SiC matrix. There are also chapters on Dispersion Fuels, Liquid Metal Fuels, Aqueous Fuel Systems, and Molten Salts as Reactor Fuels.

The 130 contributors to this volume are all reactor scientists or engineers intimately engaged with the topic they are writing about. As such the information in each topic is practical and authoritative. The text is supplemented by a large number of graphs, illustrations and tables. The volume is brought out in two-column format in excellent print on heavy-

weight paper and the strong binding will withstand constant usage.

The publishers have indicated that the price for the complete set of four volumes will be about \$ 80-90.

All Reactor establishments and research centres must possess a copy of this *Reactor Handbook* (Second Edition) and those who have anything to do with Reactor Science will find up-to-date and authoritative information in these volumes.

A. S. G.

**Mechanisms in Radiobiology, Volume II—
Multicellular Organisms.** Edited by Maurice Errera and Arne Forssberg. (Academic Press, New York and London; India: Asia Publishing House, Bombay-1), 1960. Pp. 395. Price \$ 13.00.

The extraordinary rapid pace set in the development of atomic energy after the realisation of self-sustained fission reactions has closely been paralleled by the advancement of biology in general and radiobiology in particular. From shortly after the Second World War several attempts have been made by many national and international bodies as well as by groups of competent individuals to present a co-ordinated picture of the up-to-date progress in radiobiology. The unprecedented rate and volume of the pertinent publications in this field make it imperative that such attempts at a comprehensive integration be made at regular intervals to sieve the fast emerging data from various laboratories, to critically review them and to place them in their proper place and sequence. Editors Errera and Forssberg in their *Mechanisms in Radiobiology* have attempted such a comprehensive and up-to-date survey of the field of radiobiology and adjacent disciplines. In the volume under review (Volume II), radiation effects on embryonic and adult organisms (chiefly mammals) have been discussed. Eight contributors have written five chapters on the topics of their special competence. These are:—
 (1) General Biology : Gametes, the Developing Embryo and Cellular Differentiation, by Robert Rugh ; (2) General Biology : The Adult Organism, by Carl-John Clemedson and Arne Nelson ; (3) Immunology, by Milan Hasek and Alena Lengerova ; (4) Mechanisms of Protective and Sensitizing Action, by Lorentz Eldjarn and Alexander Pihl, and (5) Recovery and Therapy of the Irradiated Organism, by D. W. Van Bekkum. It is inevitable that the articles should vary in quality. Also, it must have been a very difficult decision for the editors to allot enough space for each particular topic,

and for the contributors to decide what to include and what to exclude.

The first chapter by Rugh is impressive in its depth and extent, and the delineation of the areas where much still remains to be done has added to its intrinsic value. The second chapter on the adult organism, though extensive in its bibliography, has almost meticulously avoided the not too meagre available data on human beings and has not added much to the information already available in the excellent report of the United Nations Scientific Committee on the Effects of Atomic Radiation (1958). The concise chapter on immunology by Hasek and Lengerova is extremely stimulating specially where the most recent observations in the field have been critically reviewed and the open questions in the problem of radiation chimeras have been discussed. The remaining two chapters have also fairly extensively dealt with their respective topics and are well presented. It is probably impossible to avoid overlapping and repetitions during the review of closely allied and inter-linked scientific disciplines, especially when such reviews are attempted by different individuals or groups. This volume is no exception and such overlapping can be seen between chapters one and two as well as between chapters three and five. But to the credit of the editors, it must be admitted that in this volume they are extremely limited and by the very nature of the topics probably inevitable. The paper and printing on the whole is good, though a few typographical slips can be noted and some of the photo-micrographs might have been improved. This volume will be useful to research workers, students and others interested in radiobiology.

One drawback of such extensive reviews in successive different volumes of a fast expanding field of science (as the editors themselves foresaw it) is the quite sizable leeway left between the stage of planning and that of publication of the book. This has to be remembered while appreciating the observations and conclusions in the different chapters.

V. R. KHANOLKAR.

Methods of Biochemical Analysis, Vol. 8. Edited by D. Glick. (Interscience Publishers, New York), 1960. Pp. ix + 400. Price \$ 10.00.

The eighth volume of *Methods of Biochemical Analysis* contains articles on some of the techniques of Biochemistry introduced in recent years, all contributed by specialists in their respective fields. Among the topics considered are Gas-Liquid Chromatography, Determination

of Neuraminic Acids and the Adaptation of Heatburst Microcalorimetry for the Accurate Determination of Thermodynamic Constants of Biochemical Reactions.

In the first article A. T. James describes the principles and apparatus used for the determination of fatty acids by gas-liquid chromatography. The extraction, saponification and esterification of lipids, the separation of short and long-chain fatty acids, the methods for their identification and quantitative determination and the various types of detectors which are in vogue, are dealt with in great detail.

In the second chapter, A. M. Chase reviews the extraction and purification procedures for the preparation of luciferases and luciferins from *Cypridina hilgendorfii* and from luminous bacteria like *Achromobacter fischeri*. After discussing the photographic methods, the use of photo-multiplier photometer and the light integrator employing a vacuum tube electrometer, the details of assay procedures are given and the applications of these bioluminescent systems for micro-determination of biologically important compounds like coenzyme A and ATP are clearly pointed out.

In recent years enzymes have, by virtue of their high catalytic activities, precise steric and positional specificity as well as high substrate affinities, assumed importance as analytical tools. Paul Talalay describes in this volume the use of purified hydroxysteroid dehydrogenases for the specific microestimation of steroid hormones and their metabolites.

J. E. Scott shows how the reaction with long chain quaternary ammonium compounds may be exploited for the isolation and fractionation of acid-polysaccharides. The author draws pointed attention to the wide applicability of these methods and visualises that principles based on charge density of the poly-electrolyte should find application in the resolution of borate complexes of the neutral polysaccharides.

Sialic acids have assumed prominence as components of mucoproteins and of certain lipopolysaccharides. Details of the methods of isolation and characterisation by infra-red X-ray crystallography and colorimetric estimation of these compounds are given by Whitehouse and Zilliken.

The multiplicity of naturally occurring porphyrins and their existence in isomeric forms have made their quantitative analysis extremely difficult and cumbersome. Schwartz, Berg, Bossenmaier and Dinsmore in their article on the determination of porphyrins in biological materials give a summary of the physico-

chemical properties of these compounds which is followed by details of analytical procedures based on fluorimetry. Details of preparation of hemin, protoporphyrin, metalloporphyrins and porphobilinogen are also included.

The use of isolated pieces of frog skin for the quantitative determination of melanocyte-darkening and lightening agents is described by A. B. Lerner and M. R. Wright. The authors also give details of 'Single Response Balance Design Test' to correct for variation in response of skin specimens obtained from different frogs.

Particularly valuable to the physical biochemist is the last chapter on "Principle and Method of Heart Burst Microcalorimetry and the Determination of Free Energy, Enthalpy and Entropy Changes" by C. Kitzinger and T. H. Benzingen. The novel principle of Heat Burst Microcalorimetry, the methods by which it can be adapted for routine work in biochemical laboratories and the instrumentation required are all explained with exemplary clarity.

At the end of each chapter there is a fairly extensive bibliography. A few printing errors are noticeable in pages 201, 295 and 306. However, the general get-up of this volume is excellent and as a compendium of analytical information, it should serve as a very valuable reference to research workers in Biochemistry.

P. S. SARMA.

Current Problems in Animal Behaviour. Edited by W. H. Thorpe and O. L. Zangwill. (Cambridge University Press, London, N.W. 1), 1961. Pp. xiv + 424. Price £ 2·5-0.

This is a collection of 14 essays with some introductory chapters by the editors. Most of the authors are students of animal behaviour, but some are human psychologists or physiologists, and they have some very pertinent things to say about animals. The field is rather restricted. There is, for example, no reference to the work of Lindauer on communication between bees, of Otto Köhler on counting by birds, of Konorski and Skinner on behaviour in general. The book is not a text-book, but reflects the interests of one particular group.

Many of the facts are interesting, important, and well presented. But most of the authors seem to assume that a mechanistic account of the brain, in which each part has a function, is possible, though Gregory asks some incisive questions about the hypothesis. As we cannot describe the electrical properties of a copper wire except in terms of its properties as a whole, it seems to the reviewer unlikely that we shall be more successful with the brain,

But the list of alternative explanations of Lashley's result given on p. 73 does not appear to include quantisation.

Many of the studies reported here, for example, those of Blest on protective displays in moths, of Crook on bird flock organization, of Hinie, Thorpe, and Vince, on learning capacity in birds of different ages, with special reference to recognition of parents, could have been done in India with no apparatus, and might very well give novel results if performed on Indian species. Indian workers wishing to study animal behaviour under laboratory rather field conditions would be well advised to read this book.

J. B. S. HADWANE

Studies on *Physalia physalis* (L.) Part 1 Natural History and Morphology By A. K. Totton. Part 2 Behaviour and Histology, by G. O. Mackie. "Discovery" Report, Vol. XXX, 1960, pp. 301-67 and 369-408. Issued by the National Institute of Oceanography (University Press, Cambridge). Price £ 3-10-0 net.

Physalia physalis, the Portuguese-man-of-war is an interesting animal known since long. The gulf extant in our knowledge of this animal becomes considerably narrowed when one studies the above two contributions by Totton and Mackie. The first part by Totton (who has already contributed considerably to our knowledge of the Siphonophores of the Indian Ocean, vide, "Discovery" Rep., 1954, 27, 1-162) is on the *Natural History and Morphology* and the second part by Mackie on the *Behaviour and Histology*.

In the first part, in a short introduction, Totton explains why this jelly fish, *Physalia*, is known as Portuguese-man-of-war. The author gives a detailed account of the method adopted by him in his researches. This would be of considerable help to those engaged in the investigation of such delicate animals. The animal has also been studied *in situ* in the field. There is a welcome non-technical description of *Physalia* which serves as a fitting introduction to the succeeding technical account. The doubt regarding the existence of two species of *Physalia* is dispelled. The animal occurs in two forms, the right-handed and the left-handed and this aspect is also dealt with. The author has studied in the field the angle of drift, the rate of drift and the somersaulting phenomena of the animal in the open calm water when breeze is absent. Detailed information is supplied regarding the stinging powers and toxicology of the

animal with a good number of citations. The author gives the details of the life history of the hypertrophied gonadial larva, the medusa and the earlier or older larva, the polyp and finally the medusoid gonophore. The pattern of budding has been studied in order to trace the actual right from a very early stage and is illustrated by photographs. The characteristics of sexual reproduction are outlined. The author also gives some confusion existing in the regard as to whether the so-called "male" gonophores are female and the "female" gonophores are male gonophores concerned in reproduction. The other points made are the jelly covering of the tentacles, the siphonophores, the basal ampulla of the tentacles are homologous with the maxillae of the tentacles of other siphonophores, their walls being lined with nematocysts, the gonophores at tentacles are more complex and probably highly evolved than in other ex-siphonophores and are lined in bands in the celoecium of female gonophores. The author has also given a list of papers on the living animal with regard to its characters.

The second part by Mackie deals with the Behaviour and Histology of *Physalia* and is complementary to the first part. The first part on Histology, as the author himself states, is also complementary to that account in the *Discovery* Rep. The methods employed should be of great use to workers on similar organisms. The author deals with the float and its response to water temperature, and the reaction of the tentacles, parapodia and other appendages to stimulation. After a short introduction to static and static testing technique employed in histological studies the author deals at length with the biology of the muscular system, the nervous system, the mesogloea, gas gland, nemocytes and digestive region, thus contributing considerably to our knowledge on these aspects. The author has recorded 20 (2 m) chromosomes during mitosis.

Both the accounts are well presented with a review of earlier relevant literature illustrated by several figures and a large number of excellent photographs. They also contain at the end a comprehensive bibliography. One error was noticed, viz., in the citation of Totton and Mackie 1956, on page 405, the concerned locus of publication should be *Nature*, 177, 290, and not *Nature*, 178, 1476-77. Both the authors and publishers are to be congratulated in bringing out such an excellent piece of research work. The volume should find a place in all institutions where biology is taught.

R. ISTHARMAKAR

Qualitative Organic Analysis. By B. Haynes. (Cleaver Hume Press, 31, Wrights' Lane, Kensington, London, W. 8), 1961. Pp. 239. Price 17 sh. 6 d.

As the title implies, the volume under review deals exclusively with *qualitative* analysis of organic compounds. Preparation of compounds of synthetic value or quantitative methods of analysis are not included.

Divided into five parts, the book deals with preliminary examination, classification, separation of mixtures and identification of the components by preparation of derivatives. Tables of melting-points and boiling-points of most common organic compounds encountered in class-room work are given. A useful appendix for the preparation of standard analytical reagents is also provided. Qualitative tests are well emphasised with their limitations while points of technique are clearly brought out. Original references are given for a large number of procedures for preparing derivatives. Some of these are to quite recent publications.

The book is well got up, has an attractive laboratory note-book appearance and is free of errors. For undergraduate qualitative organic work the book is warmly recommended.

B. S. T.

Biological Activities of Steroids in Relation to Cancer. Edited by Gregory Pincus and Erwin P. Vollmer. (Academic Press, New York and London), 1960. Pp. xii + 530. Price \$ 15.00.

This book represents the record of the proceedings of a Conference on "Biological Activities of Steroids in Relation to Cancer" sponsored by the Cancer Chemotherapy National Service Centre, National Cancer Institute, National Institutes of Health, U.S. Department of Health, Education and Welfare, held at Vergennes, Vermont, on October 2nd, 1959.

The papers presented at the symposium have been brought together under five broad groups. The first, serving as introduction, contains one paper on "Steroids, Growth and Cancer". The second group contains two papers on the subject of "Steroid Structure and Function". The third group contains ten papers on the subject of "Steroid Metabolism and Biochemistry". The fourth group contains five papers dealing with the problem of "Steroid and Experimental Tumours". The fifth group contains fourteen papers on the subject of "Hormones and Human Cancer". As mentioned by the editors in the preface to the book "These meetings did not

lead directly to solutions and had not been expected to do so. If there was any consensus, it was more a postulate than a conclusion, that the role of steroids in tumour genesis, growth and regression involves more than a simple drug-target tissue relationship".

The editors deserve to be congratulated on the uniformity of presentation achieved and in bringing together the work done by many distinguished scientists in the field. The publication will, doubtless, prove of great value to research workers in the field of cancer.

M. SWAMINATHAN.

The Thyroid Gland, *British Medical Bulletin*, Vol. 16, No. 2. (The Medical Department, The British Council, 65, Davies Street, London, W. 1), May 1960. Pp. 89-174. Price 20 sh.

The application of the newer techniques of chromatography and the radioactive isotope tracer studies, during the last ten years, has considerably advanced our knowledge of the function of the Thyroid gland.

The detection of the natural occurrence of tri-iodothyrooxine and the development of the concept that thyroxine is not the only hormone but is one of a family of iodine containing amino-acids secreted by the thyroid is a fundamental observation of great importance. Discovery of two types of antithyroid drugs, those like thiocyanate and perchlorate inhibiting the thyroidal iodine concentrating mechanism; and thiourea and related compounds allowing iodine concentration but preventing its incorporation into organic compounds, has given some insight into the biosynthesis of the thyroid hormones.

The nature, distribution and properties of thyroxine binding protein, and its influence on clinical disorders has brought to the forefront the importance of the study of the hormonal transport mechanisms. The role of these binding substances in the two-way distribution of the hormone, between the mother and the foetus during embryogenesis and foetal development has attracted considerable attention.

Recent researches have thrown considerable light on the production, actions, assay and uses of the thyroid stimulating hormone.

Genetic aspect of diseases is a conspicuous feature of modern medical research. The familiar incidence of thyroid disease, methods of inheritance, congenital deafness and goitre and utilisation of 'taste blindness' to phenylthiocarbamide as a means to determine the type of goitre, present definite advances in our knowledge of thyroid disease.

Another striking discovery in the field of thyroid research is the demonstration of the formation of thyroid auto-antibodies. The implication of this observation in the wider immunological problem, in general, needs no emphasis.

This monograph, besides discussing the topics referred to above, also presents many other specialised aspects of thyroid research highly useful to biochemists and clinicians.

M. SIRSI.

The Tenth Symposium of the Society for General Microbiology—Microbial Genetics. Edited by W. Hayes and R. C. Clowes. (Cambridge University Press, London, N.U. 1), 1960. Pp. 300. Price 42 sh.

The coming of age of *Microbial Genetics*, the most fundamental of biological sciences, was heralded by the discussion of many of its ramifications at the Tenth Symposium of the Society for General Microbiology. Biochemical Genetics of fungi started some two decades ago, when gradually extended to bacteria, became complex and its techniques "esoteric". This was not very surprising since recombination of genes occurring as a consequence of sexual reproduction in higher organisms is achieved in bacteria by a variety of mechanisms. Phenomena reminiscent of sexual reproduction occurs in *Escherichia coli*. But recombination of genes is also achieved by infection or "contagion". What is more, bacterial genes could be transferred either by phages or even as naked deoxyribose nucleic acid. These transmissible heritable agents in bacteria are now referred to as "Episomes", since they may be added to or lost from a bacterial genome and may remain autonomous or get integrated into the bacterial chromosomes.

The importance of deoxyribose nucleic acid as the site of genetic information has led to the development of Molecular Genetics which attempts to elucidate the physico-chemical structure of the genetic material. The last field of endeavour, started barely eight years ago, is legitimized by its inclusion in the Symposium.

The volume deals with a "complex and esoteric discipline". But it should be of interest to a wide circle of readers since some of the important discoveries in the subject were made by interlopers into that field!

M. K. S.

Books Received

From : (Academic Press Inc., Pub., 111, Fifth Avenue, New York-3 ; India : Asia Publishing House, Nicol Road, Bombay-1) :

International Review of Tropical Medicine (Vol. I). Edited by David Richard, Lincicome, 1961. Pp. xii + 300.

Pure and Applied Mathematics, Vol. IX—Solution of Equations and Systems of Equations. By A. M. Ostrowski, 1960. Pp. ix + 202. Price \$ 6.80.

Solid State Physics (Vol. XI)—*Advances in Research and Applications*. Edited by Frederic Seitz and David Turnbull, 1960. Pp. xvi + 438. Price \$ 12.50.

Advances in Catalysis and Related Subjects, Vol. XII. Edited by D. D. Eley, P. W. Selwood, and P. B. Weisz, 1960. Pp. x + 324. Price \$ 11.00.

The Nucleic Acids (Vol. III). Edited by A. G. Norman, 1960. Pp. xi + 464. Price \$ 12.50.

From : (Cambridge University Press, London, N.W. 1) :

A Second Course in Statistics. By Robert Loveday, 1961. Pp. xi + 155. Price 10 sh.

Radio-waves in the Ionosphere—The Mathematical Theory of the Reflection of Radio-waves from Stratified Ionised Layers. By K. G. Budden, 1961. Pp. xxiv + 542. Price 95 sh.

Numerical Methods of Curve of Fitting. By P. G. Guest, 1961. Pp. xiv + 422. Price 80 sh.

From : (Interscience Publishers, Inc., 250 Fifth Avenue, New York 1).

Treatise on Analytical Chemistry—A Comprehensive Account in Three Parts—Vol. 2, Part I—*Theory and Practice*. By I. M. Kolthoff and Philip J. Elving, 1961. Pp. xx + 1308. Price \$ 16.00.

Basic Principles of Fission Reactors. By W. R. Harper, 1961. Pp. viii + 314. Price \$ 7.50.

Introduction to the Theory of Ionized Gases. By J. L. Delcroix, 1960. Pp. xi + 149. Price Cloth bound \$ 3.40, Paper bound \$ 2.50.

Physics and Archaeology. By M. J. Aitken, 1961. Pp. x + 181. Price \$ 6.00.

The Chemistry of Heterocyclic Compounds (Vol. XIV). Edited by Erwin Klingsberg—*Pyridine and its Derivatives*, Part II, 1961. Pp. x + 576, Price \$ 37.50, Subn. \$ 32.50.

SCIENCE NOTES AND NEWS

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Nuclear Physics and Chemistry to Messrs. M. Ramakrishna Raju and K. S. Venkateswara for their thesis entitled "Studies in Beta Absorption" and "Kinetics of Annealing of Radiation Damage in Cobalt Complexes of Proprietary Acetone Cr (III)" respectively.

Osmania University has awarded the Ph.D. Degree in Chemistry to Messrs. K. Ramaiyah and Wajid Ali Khan for their thesis entitled "Studies on Some Heterocyclic N-Oxides in Pyridine and Quinoline Series" and "Chemical Investigation of Plant Insecticides, Structural Studies of Scutellatum and Related Compounds" respectively.

Lady Tata Memorial Trust Scholarships and Grants for the Year 1961-62

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbari Dorabji Tata, 18th June 1961, the awards of scholarships and grants for the year 1961-62.

International Awards of varying amounts totalling £ 4,300/- for research in diseases of the blood with special reference to Leukaemia are made to Dr. (Mrs.) B. M. Bragance (India); Dr. L. Chieco Bianchi (Italy); Dr. H. J. Woodliff (England); Dr. Ameil and Mathe (France); Dr. G. Wynne Griffith (Great Britain); Dr. B. Lagerlöf (Sweden).

Indian Scholarships of Rs. 250/- per month each for one year for scientific investigation having a bearing on the alleviation of human suffering from disease are awarded to: Miss M. Indira (Bangalore); Mr. V. S. Rao (Hyderabad); Mr. A. K. Ray (Calcutta); Mr. S. K. Sankarappa (Madras); Mr. V. N. Gogte (Bombay); Dr. (Mrs.) Saroj Mehta (New Delhi); Dr. R. K. Panja (Calcutta).

Conference on Building Research

The Third Conference of Building Research Workers will be held at the Central Building Research Institute, Roorkee (U.P.), on 13th and 14th November, 1961 and will devote its attention to those aspects of building design and construction generally referred to as "Functional Efficiency".

The following topics will be discussed:

(a) The effect of climate on building design in

the Tropics; (b) Thermal comfort in buildings (including ventilation, natural and artificial), air-conditioning, performance of building component; (c) Acoustics of buildings (acoustical properties of materials, noise and related topics); (d) Lighting in buildings (natural and artificial); (e) Testing and standardisation of thermal and acoustical materials.

Papers on subjects mentioned above are invited. The last date for receipt of abstract of papers is 15th July 1961 and the finalised paper 15th August 1961.

Further information on the above Conference can be had from the Director, C.B.R.I., Roorkee.

Symposium on 'Production and Utilization of Medical and Aromatic Plants in India'

A symposium on the above subject will be held at the Regional Research Laboratory, Jammu and Kashmir, on 27th and 28th November, 1961.

Intending participants at the symposium are requested to send brief abstracts of their papers by August 15, 1961. Complete papers should be sent by September 15, 1961.

Further particulars can be had from Dr. I. C. Chopra, Deputy Director, Regional Research Laboratory, Canal Road, Jammu Tawi.

All-India Cancer Conference

Under the sponsorship of the Indian Cancer Society, it is proposed to hold the First All-India Cancer Conference on 8th, 9th and 10th December, 1961, at Bombay. Scientific papers on tumours and related problems are invited. The last date for sending the abstracts is 30th September 1961.

The Organizers are approaching the Railway Board to sanction Railway concession for delegates attending the Congress. Failing this, they shall bear all the lodging and boarding expenses of the delegates whose papers are accepted.

Further particulars can be had from the Honorary Secretary, Dr. D. J. Jussawalla, Indian Cancer Society, and Convener, First All-India Cancer Conference, Hospital Avenue, Parel, Bombay-12.

First European Malacological Congress

Under the auspices of the Conchological Society of Great Britain and Ireland and the Malacological Society of London it is proposed

to hold the First European Malacological Congress in London, from 17th to 21st of September, 1962.

The object of the Congress is to discuss all aspects of European Malacology and the formation of a European Malacological Union. The Congress is, however, open to all interested in Malacology from any part of the world.

The programme will include Scientific Meetings and Field Meetings. Enquiries should be addressed to the Hon. Secretary, Rev. H. E. J. Biggs, 19, Seward Road, Bromley, Kent. The Hon. Treasurer is J. F. Peake Esq., British Museum (Natural History), Cromwell Road, London, S.W. 7.

Root-Parasite—*Aeginetia indica* Linn.

With reference to the note on the above subject by Chavan *et al.* (*Curr. Sci.*, May 1961, p. 191), Shri R. S. Rao, Regional Botanist, Botanical Survey of India, Western Circle, Poona, writes: "While working on the flora of Tripura State during August 1957, I had come across small patches of *Aeginetia indica* Linn. growing profusely in small clumps along the dark humid corners in one area of Cherilam Reserve Forest which is near Agartala. In view of the absence of definite information about the host plant of this complete root-parasite, a careful search was made to trace the host roots in that area where the soil is quite soft, but no distinct host root could be located. I am however quite sure that no *Dioscorea* climbers were growing round about that area. It is therefore evident that this root-parasite grows on other hosts also and it is cosmopolitan in its nature of parasitism".

Atmosphere Temperature Fluctuations

The subject of climatic change is one which has for long interested climatologists and meteorologists, but especially so during recent years. Direct temperature observations, the recession of glaciers, the movements of fish and insects northwards in the northern hemisphere, as well as a similar movement of the tree-line have all indicated an appreciable rise in atmospheric temperature in many parts of the world during the past few decades. A recent contribution to the subject has been made by G. S. Callendar of the Ministry of Aviation, in a paper which appears in the *Quarterly Journal of the Royal Meteorological Society* (87, No. 371; January 1961). From his analysis he concludes that the rising trend is significant from the Arctic to about 45° S. lat., but is small and indeed locally non-apparent in regions below 35° N. as yet. A number of theories to

account for the rise have been advanced, and there has been much speculation as to whether or for how long it will continue. One widely held theory is to the effect that the rising trend is a result of increased incoming solar radiation, due either to an increased output of solar energy or to an increased atmospheric transparency resulting from a decrease in volcanic activity. Callendar considers that such a hypothesis is not inconsistent with the observed zonal short-period fluctuations, but that it fails to explain the pattern of the overall climatic trend. The latter is considered to be not incompatible with the increased carbon dioxide theory, which is to the effect that the trend could be due to back radiation from the additional carbon dioxide produced by fossil-fuel combustion. The points at issue seem to be: Does Nature control the whole process or has human activity caused the trend, on which Nature has merely imposed the fluctuations?

Use of Superconductors for Producing Strong Magnetic Fields

The production of strong magnetic fields by the use of superconductivity phenomena would appear to be considerably advanced by the development of a new superconducting compound of niobium and tin, Nb₃Sn, by the Bell Telephone Laboratories. The distinctive property of this material is its ability to retain superconducting properties even when exposed to fields of about 90,000 oersteds, and possibly even higher, while carrying currents of approximately 100,000 amp. cm.⁻² (see Kunzler *et al.*, *Phys. Rev.*, Letters for February 1, 1961). The new material is very brittle, but by packing a narrow niobium tube with appropriate quantities of powdered niobium and tin, sealing the ends of the tube with niobium plugs, reducing the tube by swaging and drawing it, a wire of 0.015 inch diameter which can be wound into a solenoid coil is formed. On heating the wire to about 1,000° C., the inner materials react to form Nb₃Sn, and the necessary superconducting properties are developed. Owing to mechanical difficulties associated with the substance at high fields, a large solenoid of the material has not yet been wound, but it is anticipated that these difficulties will be overcome within the next twelve months.—(*Nature*, 1961, 190, 134.)

Space Radio Telescope

Low-frequency electromagnetic radiations emitted by distant radio stars and galaxies cannot be studied by terrestrial radio telescopes because such frequencies are not transmitted

by the ionosphere of the earth. One possible method of studying this part of the cosmic radio spectrum will be by means of radio telescopes sent to flight above the earth's ionosphere. This was achieved for the first time when on January 1, 1961 a team of workers of the Harvard College Observatory launched from their experimental site at Cape Canaveral, a rocket called Blue Scott which lifted radio telescopes above the earth's ionosphere.

At the rocket altitude above the ionosphere, four small radio telescopes broadcast back to earth measurements of low frequency cosmic radio waves. Each radio telescope was composed of a transistorized receiver, the size of a pocket radio, and a collapsible antenna which extended on command to a length of ten feet. The total weight of the four radio telescopes was less than 10 lbs. They operated at frequencies between 100 Kc and 13 Mc. A preliminary study indicates that all the four telescopes had operated successfully throughout the flight in space. Space radio telescope technique shows promise of getting new information about cosmic radiation that originated thousands of light years away, about the weak magnetic fields in interstellar space, the proton and electron clouds between the sun and the earth, the radio noise from Jupiter, etc.

The radio telescopes in the Blue Scott rocket were also used to conduct a new measurement of the earth's ionosphere. A group under this project with operations centred at San Salvador Island, sent high powered coded radio pulses toward the ionosphere during the rocket's flight. Most low frequency radiation is reflected back to the earth by the ionosphere. However, it was generally expected that the ionospheric shell may have small "holes", through which a small fraction of the terrestrial radio energy could leak. With the combination of the space radio telescope and the San Salvador transmitter, the Harvard group has a new technique for studying the ionosphere and the leakage of terrestrial radiation into space. (*Jour. Frank Inst.*, 1961, 271, 244).

Plasma Diode

Plasma diode is a promising thermionic converter for use in nuclear reactors. The device utilizes the tremendous heat produced in the centre of nuclear reactor-fuel elements for the direct generation of electricity without the necessity for mechanical rotating equipment.

A thermionic converter produces an electric current by boiling electrons off a cathode, or hot metal plate, and collecting them on an anode,

a cooler plate. The application of this technique to conventional steam-generating stations is not practicable, since the temperature levels to be had in such stations are too low to permit efficient operation of direct conversion devices.

The plasma diode under development at the General Electric is a high-temperature thermionic device using caesium gas and a uranium-bearing cathode. These diodes would be built into nuclear fuel elements where the fissioning of the uranium in the cathode would provide the high temperatures—in the range 4,500° F.—needed for efficient direct conversion. An electrical lead from the fuel element would draw off the electricity.

In addition to the directly produced electricity, lower temperature heat rejected through the walls of the element would also be used to produce steam for operation of turbine generators.

Although thermionic conversion devices capable of producing approximately 20 watts per centimetre of cathode area have been demonstrated, present thermionic converters are still a long way from approaching practical application. Recent design advances at the General Electric, however, give hope that they can have an advanced plasma diode ready to be installed in a thermionic fuel element and tested in a prototype nuclear power plant within five years. (*Jour. Frank. Inst.*, 1961, 271, 247.)

Carbonaceous Meteorites

Meteorites are generally classified into the following three groups according to their composition: (1) Iron meteorites containing mostly iron (more than 90%) with nickel 8-9%, and traces of cobalt, about 0.5%; (2) Iron-stone meteorites whose average composition is 50% nickel-iron, and 50% iron-magnesium silicates (generally olivine, and occasionally with some pyroxene) and (3) Stone meteorites which show a great variety of composition and are mostly composed of olivine and pyroxene, with 5-20% Ni-Fe, about 5% troilite and about 10% plagioclase. To these may be added a fourth group, the tektites which are small glassy bodies found in isolated areas, but because no one has actually seen one fall, their classification as meteorites is still a subject of controversy.

Carbonaceous meteorites although they come in the group of stone meteorites are remarkably different from the rest. "They contain 1-5% of free carbon, which gives them a black sooty appearance, and 10-20% combined water, which no other meteorites have. They also contain

organic compounds in small amounts, as well as free sulphur, and calcium and magnesium sulphates. Instead of olivine and pyroxene, their silicate mineral is largely serpentine. They contain no nickel-iron. Only nineteen carbonaceous meteorites are known: all of them were seen to fall and were picked up soon after."

Interest in the study of carbonaceous meteorites has increased in recent years because of the significant information it leads to regarding the origin of life in planetary bodies other than the earth. Thus Nagy *et al.* using mass spectrographic method found that the fractional distillate obtained at 250-400° C., of the carbonaceous material of the Orgeuil meteorite, consisted of paraffinoid hydrocarbons of carbon numbers ranging from 15 to 24 with peaks at 18 and 23 carbon atoms. The analysis also showed presence of some cycloparaffins. They find that this distribution is largely similar to that found by them (using the same apparatus), for example, for butter or for organic materials in sediments. They conclude from this that "biogenic processes occur and that living forms exist in regions of the universe beyond the earth".

Taking for granted that the original material did contain paraffinoid elements similar to those produced in living matter, the question still remains to be determined whether they were produced by some form of life or by wholly inorganic processes.

If the material is derived from life, this must have occurred on the planetary parent body from which meteorites have been derived by fragmentation. The general consensus of opinion is that meteoritic parent bodies appear to be located in the asteroid belt between Mars and Jupiter. However, in this region the mean surface temperatures have been shown to be about -50° C. This would not appear to permit liquid water and hence any chemical evolution. Further, even if hot enough they would not be large enough to hold water vapour gravitationally and, therefore, would be dry bodies like the Moon.

Prof. J. D. Bernal offers a novel suggestion (*Nature*, 1961, 190, 130): "The only likely place for the genesis of such hydrocarbons would be a planet the size of earth at about the same distance from the Sun. Why not the Earth itself, if we are not allowed any longer to postulate, Pythagoras' anti-Earth? The Orgeuil meteorite would then be a piece of primitive

Earth shot off some hundreds of millions of years ago and again united to its parent body. Even more fanciful would be the idea that the stone derives from an earth-like planet of another solar system."

Radio Location Studies of Venus

Radio location studies of Venus were carried out recently in the USSR, when the planet was closest to the Earth (about 40 million kilometres). A wave in the middle of the decimetre band was chosen for these studies. The output of power sent from the Earth was 250 megawatts per steradian so that approximately 15 watts got to all visible surface of Venus. The emitted signal had circular polarization. The aerial with linear polarization was used for reception.

Preliminary results have led to establish a more precise value of the astronomical unit (the average distance between the Earth and the Sun) which is found to be 149,457,000 kilometres. Analysis of the radio signal reflected from Venus showed a widening of the frequency spectrum caused by the rotation of the planet. Measurement of this widening gave the period of rotation of Venus about its own axis as about 10 days. Zones with different coefficients of reflection of radiowaves were discovered on the surface of the planet.

Processing of the data continues and it is expected that the full results will be published soon.—(*Soviet News.*)

U.S. Project Mohole

The National Academy of Sciences and the National Science Foundation announced recently that the experimental drilling ship, *Cuss I*, operating in 12,000 ft. of water off the west coast of Mexico in the Project Mohole, obtained, for the first time, a sample of the so-called second layer under the softer sediments of the ocean floor. This layer, the presence of which has been previously known only by reflexions of seismic soundings, has been revealed as basalt. This hole, which was begun at Guadalupe Island on March 31, reached a depth of 490 ft. after 11 hr. of drilling. Coring then began, and cores of soft, grey-green clay of Miocene age were obtained to a depth of 560 ft. At that depth the drilling-rate abruptly decreased and when the core barrel was retrieved, it was found to contain a hard fine-grained basalt; the drilling had achieved threshold to the sima—(*Nature*, 1961, 190, 393.)

364-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, *Current Science Association*, Bangalore-6.

APPRAISAL OF NEWTON'S MECHANICS AND OF EINSTEIN'S "AUTOBIOGRAPHY"

A. T. GRIGORYAN

IN 1949, Albert Einstein wrote for a Volume, devoted to his world outlook (Albert Einstein, Philosopher-Scientist, Illinois, USA, 1949), an article which contains a brief definition of the state of physics at the time he embarked on his creative work. On this occasion he appraised the principles of classical mechanics, those of Newton's mechanics.

At the turn of the century, the conception was still valid of Newton's laws of motion as being the final solution of the fundamental problems of being. "In the beginning (if there was such a thing), God created Newton's laws of motion together with the necessary masses and forces. This is all; everything beyond this follows from the development of appropriate mathematical methods by means of deduction" (p. 19).

According to Einstein, the XIX century provided sufficient grounds for such opinion of the Newton's laws of motion. Particularly striking were the successes achieved by the theories which applied the equations in partial derivatives. Newton's theory of the propagation of sound was the first classical example of applying such differential equations. Later Euler gave the differential equations of hydrodynamics. This belongs to the theory of propagation of deformations in a continual medium. According to Einstein, the XIX century was noted for a systematic and detailed study of the motion of discrete bodies, the mechanics of the latter forming the basis of physics as a whole.

When Einstein became acquainted with the principles of classical physics, he was most impressed not so much by the structure of Newton's mechanics and the methods of solving mechanical problems, as by the application of mechanics to proper physical and physico-chemical problems. Einstein enumerates the results of applying mechanical conceptions in physics: optics as the mechanics of quasi-elastic ether, the kinetic theory of gases and atomistic chemistry (which, however, stood quite apart in the mechanical natural science of the XIX century).

Einstein wrote about himself and his student years comrades: "What made the greatest impression upon the student, however, was less the technical construction of mechanics or the solution of complicated problems than the achievements of mechanics in areas which apparently had nothing to do with mechanics:

the mechanical theory of light, which conceived of light as the wavemotion of a quasi-rigid elastic ether, and above all the kinetic theory of gases: the independence of the specific heat of monatomic gases of the atomic weight, the derivation of the equation of state of a gas and its relation to the specific heat, the kinetic theory of the dissociation of gases, and above all the quantitative connection of viscosity, heat-conduction and diffusion of gases, which also furnished the absolute magnitude of the atom. These results supported at the same time mechanics as the foundation of physics and of the atomic hypothesis, which latter was already firmly anchored in chemistry. However, in chemistry only the ratios of the atomic masses played any rôle, not their absolute magnitudes, so that atomic theory could be viewed more as a visualizing symbol than as knowledge concerning the factual construction of matter" (p. 19).

Classical mechanics may serve as the basis of thermodynamics. True enough, this requires a statistical assembly of molecules whose motions are subordinated to the relationships of thermodynamics which are backed by the immutable laws of motion and collision of bodies established by Newton's mechanics. That is why classical thermodynamics was regarded, and indeed was, a testimony of the universal nature of Newton's mechanics. Einstein wrote that "... it was also of profound interest that the statistical theory of classical mechanics was able to deduce the basic laws of thermodynamics, something which was in essence already accomplished by Boltzmann" (pp. 18-20).

Newton's classical mechanics was considered to be the basis of electrodynamics as well. This quite naturally resulted from the universal interpretation of classical mechanics. Maxwell's and Hertz's deliberate tendency was to substantiate electrodynamics from a mechanical standpoint. At the same time the objective historical tendency, which forced its way in classical electrodynamics, consisted in refusing to accept classical mechanics as the basis of physical ideas.

Einstein wrote: "We must not be surprised, therefore, that, so to speak, all physicists of the last century saw in classical mechanics a firm and final foundation for all physics, yes, indeed, for all natural science, and that they never grew tired in their attempts to base Maxwell's

theory of electromagnetism, which, in the meantime, was slowly beginning to win out, upon mechanics as well. Even Maxwell and H. Hertz, who in retrospect appear as those who demolished the faith in mechanics as the final basis of all physical thinking, in their conscious thinking adhered throughout to mechanics as the secured basis of physics" (p. 21).

Einstein perceived a deliberate revision of classical mechanics in Mach's work, *History of Mechanics*. Here one has to differentiate strictly: (1) The idea that it is impossible to erect the building of science on the foundation of classical mechanics; (2) The so-called Mach principle according to which inertia forces are a function of the interaction of masses; (3) Mach's philosophical views.

As to refusal to accept a dogmatic and universal comprehension of classical mechanics, Einstein read in the *History of Mechanics* more than it contained; Mach disputed the idea of absolutely accelerated motion in the way it was expounded in Newton's "Principles". The famous example of the revolving bucket appeared unconvincing to Mach. But his remarks did not imply, even in a vague form, the notion of other, non-classical regularities of mechanics and did not lead to the assumption of non-mechanical initial regularities of nature.

As to the philosophical ideas of machism, Einstein felt their influence in his youth, but later he consistently departed from Mach's positions to an ever-increasing extent until he passed his well-known remark about Mach as the "déplorable philosopher".*

In his criticism of Newton's mechanics, Einstein proceeded from criteria fundamentally different from those of Mach. For Einstein, the first criterion of any physical theory consisted in its conformity with the results of an experiment, by which Einstein meant cognition of the objective processes in nature. *Physical theory should conform to experiment*. But this is far from warranting directly the correctness of the theory; the results of an experiment may conform to various conceptions, and a current conception can very often be brought to accord with an experiment by means of additional hypotheses. As a matter of fact, a conception which explains a number of experimental results in a non-contradictory way does not yet possess warranted oneness, since it can be replaced by another, sometimes more general, conception which accounts for a wider range of facts.

The case in point is, however, not the extension, precise definition and generalization of the theory in connection with transition to another, wider range of phenomena. "Of the 'realm' of theories I need not speak here, inasmuch as we are confining ourselves to such theories whose object is the totality of all physical appearances" (p. 23).

Hence Einstein's first criterion admits of but one alternative appraisal: the theory in question either accords or does not accord with the totality of known physical phenomena. Naturally enough, such a conformity cannot be guaranteed for the future as the volume of empirical physical knowledge constantly increases. It is precisely for this reason that the criterion of conformity with facts (Einstein called it the criterion of "external justification") is always valid in assessing a scientific theory.

The second criterion was termed by Einstein the criterion of "inner perfection". This implies the following:

Every theory can be defined, sometimes by intuition, and sometimes in a comparatively strict way, by the degree of its logical harmony. Einstein formulated this criterion very cautiously, pointing to its inaccuracy.

"The second point of view is not concerned with the relation to the material of observation but with the premises of the theory itself, with what may briefly but vaguely be characterized as the 'naturalness' or 'logical simplicity' of the premises (of the basic concepts and of the relations between these which are taken as a base). This point of view, an exact formulation of which meets with great difficulties, has played an important rôle in the selection and evaluation of theories since time immemorial" (p. 23).

This criterion should not be reduced to determining the number of independent assumptions from which the theory proceeds. Einstein wrote about the non-comparability of the logical "quality" of one theory with that of another competing theory. Apart from a number of independent premises, their "strength" is of importance, i.e., the possibility of determining unambiguously the resulting assertions, with the exclusion of others.

"The problem here is not simply one of a kind of enumeration of the logically independent premises (if anything like this were at all unequivocally possible), but that of a kind of reciprocal weighing of incommensurable qualities. Furthermore, among theories of equally 'simple' foundation that one is to be taken as superior which most sharply delimits the

* E. Meyerson, *La déduction relativiste*, Paris, 1925, p. 62.

qualities of systems in the abstract, i.e., containing the most definite claims?" (p. 23).

Yet another component, "inner perfection," is added to the "naturalness" (logical simplicity) of the theory. The theory is more perfect if it has been selected with maximum compulsion and with least arbitrariness.

"The following I reckon as also belonging to the 'inner perfection' of a theory: We prize a theory more highly if, from the logical standpoint, it is not the result of an arbitrary choice among theories which, among themselves, are of equal value and analogously constructed" (p. 23).

Einstein did not claim that he formulated his criteria in a precise manner: "The meagre precision of the assertions contained in the last two paragraphs I shall not attempt to exercise by lack of sufficient printing space at my disposal, but confess herewith that I am not, without more ado (immediately), and perhaps not at all, capable to replace these hints by more precise definitions. I believe, however, that a sharper formulation would be possible. In any case it turns out, that among the 'vague' there usually is agreement in judging the 'inner perfection' of the theories; and even more so concerning the 'degree' of external confirmation" (pp. 23-25).

Einstein used the said criteria, above all, in tackling the question: can classical mechanics serve as the basis of physics as a whole? "External justification" for it becomes questionable in optics. First of all, the mechanical pattern of ether was in contradiction to the facts. The history of the theory of ether culminated in finally discrediting the mechanical model of ether. Maxwell's electrodynamics and Hertz's experiments which confirmed it were the decisive argument to shake the traditional appraisal of mechanics as the basis of physics.

The mechanical interpretation of Maxwell's electrodynamics became increasingly difficult as the processes in which weighable masses took no part proved to be the objects of electrodynamics. At the same time such an interpretation became less and less fruitful.

"... this mechanics as the basis of physics was being abandoned, almost unnoticed, because its adaptability to the facts presented itself finally as hopeless since then there exist two types of conceptual elements, on the one hand, material points with forces at a distance between them, and, on the other hand, the continuous field. It presents an intermediate state in physics without a uniform basis for the

entirety, which although unsatisfactory is far from having been superseded" (p. 27).

The main substance of the definition of Newton's mechanics in Einstein's *Autobiography* is related, however, to the criterion of "internal perfection". Here the target of criticism is supplied by the basic conceptions of *The Mathematical Principles of Natural Philosophy*. As a matter of fact, the criterion of "internal perfection" is related to the initial precepts of the Theory and the special case, motion by inertia, cannot be singled out in this case. If we recollect what Einstein said about the criterion of "internal perfection", we understand why it is applied to the principles of the theory of motion in a general case, i.e., the theory of accelerated motion.

Newton associates accelerated motion with absolute empty space and perceives proof of the absolute nature of accelerated motion in the appearance of inertial force. Let us remind the reader the lines from the "Principles", which outline this conception.

"The effects, which distinguish absolute from relative motion are, the forces of receding from the axis of circular motion. For there are no such forces in a circular motion purely relative, but in a true and absolute circular motion, they are greater or less, according to the quantity of the motion. If a vessel, hung by a long cord, is so often turned about that the cord is strongly twisted, then filled with water, and held at rest together with the water; after, by the sudden action of another force, it is whirled about the contrary way, and while the cord is untwisting itself, the vessel continues for some time in this motion; the surface of the water will at first be plain, as before the vessel began to move; but the vessel, by gradually communicating its motion to the latter, will make it begin sensibly to revolve, and recede by little and little from the middle, and ascend to the sides of the vessel, forming itself into a concave figure (as I have experienced), and the swifter the motion becomes, the higher will the water rise, till at last, performing its revolutions in the same times with the vessel, it becomes relatively at rest in it. This ascent of the water shews its endeavour to recede from the axis of its motion; and the true and absolute circular motion of the water, which is here directly contrary to the relative, discovers itself and may be measured by this endeavour. At first, when the relative motion of the water in the vessel was greatest, it produced no endeavour to recede from the axis; the water shewed no tendency to the circumference, nor

any ascent towards the sides of the vessel, but remained of a plain surface, and therefore its true circular motion had not yet begun. But afterwards, when the relative motion of the water had decreased, the ascent thereof towards the sides of the vessel proved its endeavour to recede from the axis ; and this endeavour shewed the real circular motion of the water perpetually increasing, till it had acquired its greatest quantity, when the water rested relatively in the vessel. And therefore this endeavour does not depend upon any translation of the water in respect of the ambient bodies, nor can true circular motion be defined by such translations. There is only one real circular motion of any one revolving body, corresponding to only one power of endeavouring to recede from its axis of motion, as its proper and adequate effect : but relative motions in one and the same body are innumerable, according to the various relations it bears to external bodies, and like other relations, are altogether destitute of any real effect, any otherwise than they may perhaps participate of that one only true motion" (Sir Isaac Newton, *The Mathematical Principles of Natural Philosophy*, London, 1803, pp. 11-12).

The appearance of inertial force means that the basis of classical mechanics, the principle according to which acceleration depends on the interaction of bodies, has been disturbed.

By calling inertia a force, we have retained the connection between the acceleration of bodies (caused by acceleration of a system and proving the absolute nature of this acceleration) and the "force", but the latter no longer expresses the interaction of bodies.

By declaring the interaction of masses to be the cause of inertial forces, Mach wanted to save the basis of classical mechanics, the dependence of acceleration on such interaction. In essence, he came out against Newton's absolute space from classical positions. Einstein initially considered "Mach's principle" a substantial element of the general theory of relativity. Later on he changed this appraisal. In his autobiography he wrote : "Mach conjectures that in a truly rational theory inertia would have to depend upon the interaction of the masses, precisely as was true for Newton's other forces, a conception which for a long time I considered as in principle the correct one. It presupposes implicitly, however, that the basic theory should be of the general type of Newton's mechanics : masses and their interaction as the original concepts. The attempt at such a solution does not fit into a consistent field theory, as will be immediately recognized" (p. 29).

The above lines are of primary historic significance ; they alone, regardless of the rest of the *Autobiography* contents, make it an important document of the history of science. Above all, the lines contain a summary assessment of Einstein's views on a highly important subject. It would be extremely significant task in compiling Einstein's scientific biography to trace the changes in Einstein's views on inertia as a function of mass interaction, and the connection between these views and cosmological ideas. As this has to do with the greatest physicist of the century, the task exceeds the limits of a scientific biography and assumes historical scientific importance. But the matter concerns not only and not even so much the history of the relativity theory. The definition of "Mach's principle" is linked with the historical interpretation of classical mechanics.

In each of his works on the general theory of relativity, Einstein criticized Newton's theory from the position of another theory which likewise proceeds from a pattern of masses moving in space and interacting on one another. Now Einstein approached the appraisal of Newton's mechanics from another, more radical position.

Further, Einstein pointed to other major defects of classical mechanics as a basis of physics from the view-point of "internal perfection" of mechanics. These include the existence of (1) the law of motion and (2) the expression for force or potential energy, each independent from one another. In classical mechanics, the law of motion is independent from the laws of the field. At the same time it is meaningless, unless the forces are predetermined. But the expression for force is chosen at random which is particularly aggravated by the requirement that the forces should depend on the position of the bodies, and not on their velocities. This requirement does not ensue in an unambiguous way from the principles of classical mechanics and is by no means self-evident. Conformity, unambiguous connection with the least number of initial principles, and the absence of any arbitrariness, all these criteria indicate that Newton's mechanics is devoid of inner simplicity and naturalness. Arbitrary for classical mechanics is also the potential function $1/r$ which determines the action of gravitational forces and forces of electrical attraction to and repulsion from a point mass or point charge which set up corresponding force fields. Einstein links this defect of classical mechanics with the idea of far action. The potential function $1/r$ in a central symmetrical solution of

differential equation $\Delta \rho = 0$, invariant with relation to rotation. The potential function is not arbitrary if it results from some law which points to its distribution in space. But such a law cannot be the initial principle of Newton's mechanics. It appeared as a description of real processes in a physical medium under the influence of facts and was directed against far action.

The above defects of classical mechanics, like the others specified further in Einstein's *Autobiography*, disturb its "internal perfection". Whereas for special theory of relativity another criterion ("external justification") was of primary importance, with the further expansion of the theory, its changeover to the general theory of relativity, the criterion of "internal perfection" i.e., simplicity, naturalness and unambiguity, played a major heuristic rôle.

The historian's important task is to clarify the real meaning of this criterion. By thoroughly examining it, we are able to note some analogy between Einstein's scientific method proper and his historical-scientific method as formulated in the *Autobiography*.

If one is to determine Einstein's scientific method proper, it may be called the method of invariants. The relativity theory meant a great triumph of the method, and the further development of this theory pointed very distinctly

to the rôle of invariant analytical conceptions in its inner structure. Einstein strove to express the objective regularities of nature by means of magnitudes invariant as to co-ordinate transformations.

The same tendency, directed towards the past, underlies Einstein's historical-scientific method.

Simplicity of a theory is the criterion of its truth. What there does the word "simplicity" mean? It can be easily perceived that Einstein does not adhere at all to the old criteria of "simplicity" according to which nature functions. The case in point is that in its development the pattern of the world becomes devoid of anthropomorphous ideas and expresses the objective reality by increasingly objective methods independent, notably, from the methods of measurement, invariant as to the selection of methods of measurement and the "reference" systems. This, likewise, is what the condition of "naturalness" comes to, and, quite clearly this time, the condition of excluding arbitrariness in deriving conclusions from the initial premises.

It goes without saying that the above remarks about Einstein's historical method and the assessment of classical mechanics refer to but a small part of those numerous and profound historical-scientific ideas which the *Autobiography* contains together with the proper physical ideas.

MINIATURE SUN CREATED BY PLASMA "PINCH"

THE photograph taken in one ten-millionth of a second, shows a miniature sun created by a plasma "pinch".

the surface of the sun—and glows brightly. The streaks of light are longitudinal views of the pinch reflected by mirrors.



The plasma, a very hot deuterium gas whose atoms are stripped of their electrons is "pinched" inward toward the centre of the tube. As it is "pinched", it is also compressed and heated to several hundred thousand degrees—hotter than

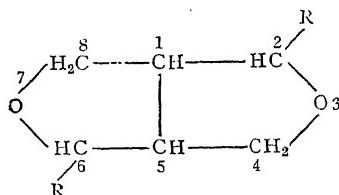
Such photographs reveal plasma instabilities and eventually make possible a controlled fusion reactor.—(General Atomic Division, General Dynamics Corporation.)

PROTON MAGNETIC RESONANCE IN SESAMIN AND ASARININS

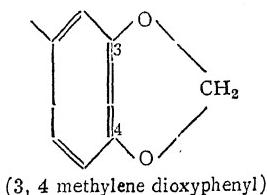
G. GOVIL, C. R. KANEKAR AND C. L. KHETRAPAL

Tata Institute of Fundamental Research and Atomic Energy Establishment, Trombay, Bombay

SESAMIN and asarinin have attracted attention of biochemists in recent years particularly because of their antitubercular activity.^{1,2} The structure of these compounds shown in formula I seems to have been fairly well established from synthetic evidence.³



where R is



(3, 4-methylene dioxyphenyl)

FIG. 1

Sesamin and asarinin are stereoisomers; in addition both the *d* and *l* forms of each of these compounds are known. It has been found that asarinin shows far more antitubercular activity than sesamin and further *d* sesamin and *l* asarinin are far more active than *l* sesamin and *d* asarinin respectively. According to Beroza³ three configurations representing three different geometrical isomers are possible for compounds having formula I (Figs. 2-4). Of these only two (sesamin and asarinin) are

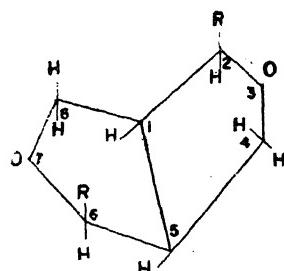


FIG. 2

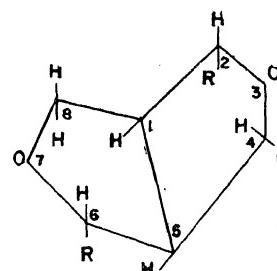


FIG. 3

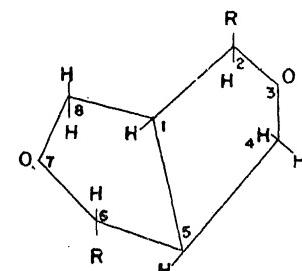
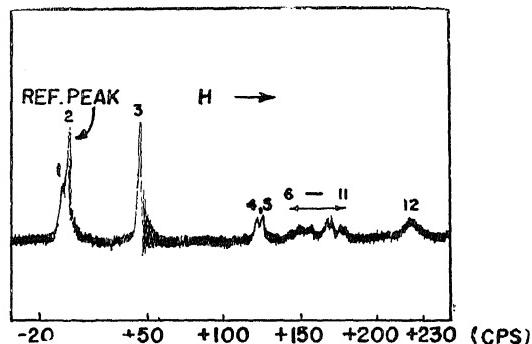
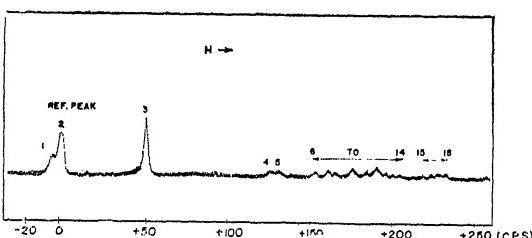


FIG. 4

known. Synthetic evidence³ indicates that asarinin has structure IV while sesamin can be either II or III.

The proton magnetic resonance investigation of sesamin and asarinin was undertaken with a view to ascertain whether it can throw any further light on the structure of these compounds.

The spectra were recorded with the help of the Varian Associates' High Resolution Spectro-

FIG. 5 (i). Spectrum of *d*-sesamin (frequencies are relative to ref. peak).FIG. 5 (ii). Spectrum of *d*-asarinin (frequencies are relative to ref. peak).

meter. Earlier, attempts made to study these compounds at 30 Mc./s. gave somewhat inconclusive results because of the low intensity of

the lines resulting from the relatively poor solubility of these compounds in a suitable solvent. Measurements were, therefore, finally made at an operating frequency of 60 Mc./s. where higher intensity and better resolution were obtained.

Solutions were made in CCl_4 through which nitrogen gas was passed for some time to remove any dissolved oxygen. The purity of the samples was checked by their melting-points and optical activity before they were sent to us. Due to the low solubility of these compounds a high R.F. (about 50 db. below 0.5 watts) had to be used with a relatively fast scanning rate to avoid saturation effects. The resolution attained was, therefore, of the order of 2 cps. The line shifts were measured for strong lines, relative to cyclohexane as an internal standard by the usual side band technique within an accuracy of 2 cps. The relative distances between the individual peaks of the spectrum of each compound were however measured with greater accuracy (0.3 cps.).

The spectra of *d* sesamin and *d* asarinin are shown in Fig. 5. The values of the line shifts for individual lines in the spectrum have been tabulated (Table I) in terms of frequencies in cps. with reference to the second phenyl peak (marked reference peak). The chemical shifts for the various groups (expressed in parts per million relative to cyclohexane) are also given in Table I.

The spectrum of sesamin consists of 12 lines while that of asarinin shows more lines (at least 18 in number). An inspection of structures II, III and IV, shows that structure IV has more non-equivalent protons. More lines are therefore expected for structure IV than either II or III; the last two structures are expected to give the same number of lines. The spectrum, therefore, enables us to conclude that asarinin has an unsymmetrical structure IV with more non-equivalent protons in agreement with the synthetic evidence.

The peaks No. 1 and 2 in each spectrum are assigned to the phenyl protons in the side chain *R*. There are six such protons in each molecule. The values of the chemical shifts for these two lines are within the range observed for phenyl protons (-4.8 to -6.3 p.p.m. c.f. Meyer, Saika and Gutowsky⁴). There are also four protons of the dioxymethylene group in the side chain. Owing to the proximity of two oxygen atoms of the dioxymethylene group, one expects a shift to much lower fields for these protons as compared to the protons in CH and CH_2 in the main rings. Also the intensity of line due

to these protons should be $2/3$ of that of the phenyl protons. These considerations indicate that line 3 arises from the resonance of dioxymethylene protons. The remaining lines arise from the protons attached to the fused furan rings.

Because of the several types of spin couplings the spectrum of sesamin and asarinin is expected to be quite complicated. A complete analysis of all the lines has not, therefore, been attempted. It is, however, possible to ascertain the ranges of the chemical shifts for various non-equivalent groups and to identify the different structures II, III and IV from one another. From the measurements made at another operating frequency (e.g., 30 Mc./s.), it is further possible to distinguish between chemical shifts and coupling constants.

A model of these molecules made in the laboratory indicates that the two tetrahydrofuran rings are themselves planar but are fused to each other in such a way as to give a chair-type molecule. In such a configuration the protons are either in the cis- or trans-position with respect to one another. Since the HCH angles in such a fused ring are not expected to be much different from those in a 6-membered ring, one expects that the coupling constants for sesamin and asarinin should be of the same order of magnitude as in substituted cyclohexanes. The coupling between the cis-position in such a chair-type configuration will be analogous to the equatorial coupling in substituted cyclohexane (~ 3 cps.) while the coupling between the protons in trans-position will be analogous to the axial-axial coupling (~ 7 cps.).⁵

In sesamin which can be either II or III, the protons can be divided into 3 non-equivalent groups (a) those in position 2 and 6 (b) those in 4 and 8 and (c) those in position 1 and 5. The (a) group protons are expected to exhibit resonance at the lowest field because of their linkages with oxygen atoms and phenyl groups; the (c) group protons are likely to resonate at the highest field as they are β to oxygen atoms; and the (b) group resonance should occur in between. On these considerations lines 4 and 5 have been ascribed to (a) group, the broad peak occurring at highest field appears to be due to (c) group while those between 6 and 11 are due to the (b) group split up by various coupling constants. The chemical shift of (b) group protons agrees with the chemical shift of α protons in tetrahydrofuran (-2.2 p.p.m. relative to cyclohexane observed in our laboratories). The multiplet structure due to spin coupling does not seem to have been resolved for (c) group. In

structure II, the (a) group protons are placed cis with respect to the (c) group. This should result in a doublet due to (a) group separated by about 3 cps. On the other hand, for structure III this doublet separation should be of the order of 7 cps. The lines 4 and 5 show a separation of 3.9 cps., at both the operating frequencies. This therefore suggests that sesamin has structure II. It would be interesting to obtain

constants referred to above and the valence of many of the protons attached fused rings. No attempts have been made to analyse this part of the spectrum but the values of the chemical shifts for the —C₆H₅ and —CH₂ attached to the rings have been reported in Table I. These values are in agreement with the corresponding values for the d-form and are in the range expected for the

TABLE I
Spectra of d-sesamin and asarinins

Group of protons	d-sesamin				d-asarinin				Frequency separation (cps.) referred to 2nd phenyl peak
	Peak No.	Frequency separation (cps.) referred to 2nd phenyl peak	Shift in p.p.m. relative to 2nd phenyl cyclohexane peak	Peak No.	Frequency separation (cps.) referred to 2nd phenyl peak	Shift in p.p.m. relative to 2nd phenyl cyclohexane peak	Peak No.	Frequency separation (cps.) referred to 2nd phenyl peak	
Phenyl ..	1	- 3.8	- 5.31 to - 5.25	1	- 4.7	- 5.35 to - 5.27	—	- 4.4	0
Dioxymethylene ..	3	46.6	- 4.47	3	46.4	- 4.50	—	47.6	—
C ₆ H α to phenyl and >O group ..	4	122.7	- 3.20 to - 3.13	4	114.6	- 3.36 to - 3.26	—	116.1	—
—CH ₂ α to >O but not in α position to phenyl group ..	5	126.6	—	5	120.3	—	—	121.7	—
—CH ₂ α to >O but not in α position to phenyl group ..	6	145.2	..	6	139.8	..	—	141.3	—
—CH ₂ α to >O but not in α position to phenyl group ..	7	153.3	..	7	146.5	..	—	148.1	—
—CH ₂ α to >O but not in α position to phenyl group ..	8	160.0	- 2.82 to - 2.22	8	151.3	..	—	152.6	—
—CH ₂ α to >O but not in α position to phenyl group ..	9	168.6	..	9	162.8	..	—	162.3	—
—CH ₂ α to >O but not in α position to phenyl group ..	10	173.4	..	10	169.8	- 2.94 to - 2.10	—	167.2	—
—CH ₂ α to >O but not in α position to phenyl group ..	11	181.3	..	11	175.7	— 2.10	—	175.6	—
—CH ₂ α to >O but not in α position to phenyl group ..	12	223.5	- 1.50 (Broad line)	12	181.8	..	—	181.2	—
—CH ₂ β to >O ..	13	—	..	13	185.3	..	—	185.6	—
—CH ₂ β to >O ..	14	—	..	14	189.8	..	—	189.8	—
—CH ₂ β to >O ..	15	—	..	15	214.3	..	—	213.5	—
—CH ₂ β to >O ..	16	—	..	16	219.8	- 1.69 to - 1.43	—	219.3	—
—CH ₂ β to >O ..	17	—	..	17	225.1	- 1.43	—	224.1	—
—CH ₂ β to >O ..	18	—	..	18	230.1	..	—	229.6	—

n.m.r. of compound of structure III if such a compound could ever be synthesised and to test the prediction of a relatively large coupling constant for the protons in 2 and 6.

In asarinin (structure IV) the protons in 2 and 6 positions are placed unsymmetrically with respect to each other. The proton in 2 position is coupled to proton in 1 position much in the same manner (cis) as in sesamin. The coupling between them is, therefore, expected to be of the order of 3.9 cps. The other protons in trans-positions 5 and 6 will experience a much larger coupling (~ 7 cps.). One would, therefore, expect a quartet in the spectrum for these two protons. Actually a doublet has been observed for this group (lines 4, 5) with a separation of 5.6 cps. at both the operating frequencies. Since the chemical shift between the proton in 2 and 6 positions seems to be negligible, we believe that the doublet is due to the overlapping of the four lines which could not be resolved as our resolution is of the order of only 2 cps. The remaining spectrum of asarinin arises on account of several coupling

The spectrum of d and l forms of asarinin are identical (within the experimental limits of investigation) and it does not seem to distinguish between the two optical isomers by the n.m.r. method.

The authors wish to thank Dr. S. Ramaswamy of the Indian Institute of Science, Bangalore, for having initiated this problem by kindly supplying pure samples of the isomers and Shri. S. C. Mathur for his help. The authors are also grateful to Professor S. S. Dharmatti for his encouragement and general guidance in this investigation.

1. Gangadharan, P. R. J., Narayan Misra, Iyer, B. H., *Curr. Sci.*, 1952, **21**, 24.
2. Ramaswamy, A. S. and Sirsi, M., *Nature*, 1957, **1**, 44.
3. Beroza, M. and Schechter, M. S., *J. Am. Chem. Soc.*, 1956, **78**, 1242.
4. Meyer, L. H., Saika, A. and Gutowsky, H. S., *J. Am. Chem. Soc.*, 1953, **75**, 4567.
5. Bernstein, H. J., Schneider, W. G. and Gutowsky, H. S., *High Resolution Nuclear Magnetism*, 1958, p. 193.

THE CARNEGIE INSTITUTION*

THE Year-Book No. 59 of the Carnegie Institution of Washington is again a highly informative scientific publication of current interest. It records the progress of work and the new achievements of the seven departments of the Institution for the year July 1, 1959 to June 30, 1960. Researches of a basic nature which will extend the frontiers of knowledge have always been the primary concern of the Institution. In this objective the different Departments work in co-ordination, and the subjects of study range from the tiniest particles of life on this planet to the outermost galaxies detectable in space. Life sciences play a major role in the Institution's activities. In these studies as many as five departments take part and results of significance obtained during the year have been included in the Year-Book.

Astronomical discoveries are always exciting and are taken for granted without much questioning. The Mount Wilson and Palomar Observatories have reported some spectacular observations during the year. Dr. Rudolph Minkowski (whose retirement after a long stretch of meritorious association with the Institution has been announced) photographed through the 200-inch Hale telescope the most distant astronomical object thus far discovered. It is a cluster of galaxies apparently receding from the earth at the rate of 138,000 km./sec., almost half the speed of light. It may be noted that this cluster was first located by radio astronomy methods, first at the Cavendish laboratory, England, and later at the California Institute of Technology. Accurate location by radio-receivers made possible the remarkable spectral photographs obtained by Minkowski.

During the year not only the farthest astronomical object has been photographed but the oldest cluster has been found. This is NGC 188, whose age according to Sandage of Mount Wilson is 25 billion years. The farthest and the oldest are not the only ones to go into record. A star with the strongest magnetic field so far has been found by H. W. Babcock. It is the A-type star HD 215441 whose spectrogram with the 200-inch reflector revealed Zeeman splitting corresponding to a magnetic field of 34,400 gauss (cf. sunspot magnetic fields of 4,000 gauss).

There is no doubt that these extremes supply crucial tests for cosmological theories.

One of the major programmes in which the Geophysical laboratory, jointly with the Department of Terrestrial Magnetism, has been actively engaged in recent years is the charting of the phase equilibria of important mineral systems. The primary methods for these investigations lie in the use of high-pressure, high-temperature equipment for synthesizing and metamorphosing minerals in the laboratory. During the year Boyd and England succeeded in synthesizing diamond from graphite. The synthesized product resembled natural carbonado diamonds used for industrial purposes, and were obtained at 75,000 atmosphere and 1,500° C., in grain sizes of as much as 0.1 mm. Progress on the work with olivines has yielded some significant results. A dense spinel form of the iron olivine fayalite was obtained under pressures of 60-80 kilobars, and it was found that the transition from fayalite to spinel occurred in about the same pressure-temperature range as the inversion from graphite to diamond. These results are significant in the sense that the fayalite-spinel transition may explain the marked seismic discontinuity known to exist at a depth of about 400 km. in the earth's mantle.

In the Department of Terrestrial magnetism the investigations of the "equatorial electrojet" in the upper atmosphere above Peru which formed part of the IGY programme was completed during the year. The 60-ft. parabolic reflector whose completion has been announced is expected to be used for major contributions in the observing programme of the Department. In the Department's activities devoted to biophysics the results obtained on the dynamics of the syntheses of proteins and nucleic acids by intact living cells are fresh and striking.

The Department of Plant Biology has been chiefly concerned for several years with the study of different forms of chlorophyll that occur in living plants. The primary question around which much of the year's work has centred is whether or not the different forms of chlorophyll *a* all participate in photosynthesis, and, if so, in what manner. It was found that at least two of the forms of chlorophyll *a* function differently. The two pigment mechanism is an essential part of photosynthesis. Experiments during the year lead to the conclusion that the photophosphorylation reaction and the formation of reducing power, two well-known parts of the

* Carnegie Institution of Washington Year-Book No. 59 (The Director of Publications, Carnegie Institution of Washington, 1530, P. Street, North-West, Washington, 5, D.C.), 1960. Pp. lvii+515, Price : Paper bound \$ 1.00 ; Cloth bound ; \$ 1.50.

photosynthetic process), are driven by separate pigments.

Dr. M. Demerec, Director of the Department of Genetics, retired from the Institution on June 30, 1960. He joined the Institution in 1923, and throughout his lifelong association with it his researches have been directed towards elucidating the structure, the function, and the mutability of genes. Further studies in this field during the year carried out with *Salmonella typhimurium* and hybrids obtained by crossing *S. typhimurium* with *Escherichia coli* have been reported.

A notable achievement in the Department of Embryology during the year is the successful visualisation of circulation in the maternal placenta by the techniques of radioangiography.

The experiments were conducted on pregnant Rhesus monkeys. The technique lies in injecting into the femoral artery 1 ml. of radio opaque dye under 90 pounds pressure (the high injection pressure is an essential part of the technique), and following the course of the dye through the various arteries, and finally through the intervillous space of the placenta. The visual displaying of the circulation uses a combination of image intensifier and television system.

It is needless to mention that the Year Book of the Carnegie Institution, Washington, containing the latest progress in the different fields of fundamental investigation undertaken by the Institution, are valuable additions to current scientific literature.

PLANNED FOREST DEVELOPMENT FOR INDIA

DR. J. A. VON MONROY, the FAO expert on forest industries, held recently an assignment in India to help design an overall plan for the integrated development of India's forest and forest industries. According to him forest resources in India, as they stand now, are not enough to meet the requirements of the country's present population of 420 million, let alone the estimated population of 600 million for 1975. India is famous for the production of valuable slow-growing timbers. However, present conditions demand a vast increase in the supply of wood, which can only be met by planting fast-growing species. Dr. von Monroy's proposal is to select about 1% of India's forest area, in the most productive parts of the country, and to plant 150,000 acres per year over the next ten years with trees which mature within 15 years. This development, coupled with intensive management arrived at raising the forest yield per acre, should double the present production of industrial wood. Dr. von Monroy's other recommendations include the development of the Himalayan coniferous forests, expanded use of low grade timber, and the use of building boards instead of solid timber.

The second phase of the programme is about the forest industries. It is estimated that for paper alone the demand will jump from the present 450,000 tons to 2.1 million tons by 1975. This can only be met by a dramatic increase in the number of pulp and paper mills, as well as fibreboard and wood particle board plants, coupled with increased use of fuelwood and adoption of modern processing techniques, such as the high yield system. A pre-investment survey must be carried out now to determine exactly where these industries shall be located.

It is also expected that fuelwood requirements, mostly for cooking, will jump to the astounding peak of 100 million tons by 1975. A large fuelwood plantation programme has been planned, but this must be supplemented by making better use of supplies, such as popularizing more efficient simple kitchen stoves through community development projects. A very important item in India is the supply of minor forest products, such as tanning material, resin, medicinal plants and oils. Much of the demand can be met by creating small-scale cottage industries, which will, of course, greatly help rural development. (FAO News)

A CORRECTION

OUR attention has been drawn to the following statement which appeared in *Current Science*, 1956, Vol. 25, p. 283. "Dr. Ramdas began his career as a Palit Research Scholar from 1923-26 under Sir C. V. Raman and discovered the phenomenon of the 'Scattering of Light by Pure Liquid and Sound Surface'." On a reference to the original publications of the time, we

find that the statement should have read: Dr. Ramdas began his career as a Palit Research Scholar from 1923-26 under Sir C. V. Raman and collaborated with Professor Raman in his fundamental researches on the scattering of light by liquid and solid surfaces. We regret the publication of the earlier erroneous report.

LETTERS TO THE EDITOR

THE USE OF THE THREE-ELECTRODE TRIGGER IN THE SPECTRAL STUDY OF EXPLODING WIRES

THE circuit which is usually employed for exploding a short metal wire W, having a resistance of a few milliohms, by the discharge of a condenser C charged to a high voltage is shown in Fig. 1.¹ The spark gap G has been replaced

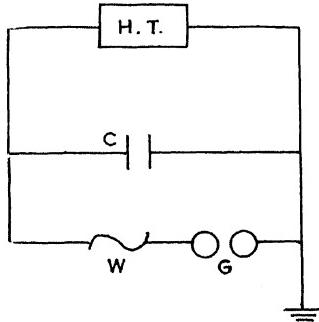


FIG. 1

by various types of triggering devices in order to reduce the energy losses in the spark gap G and to make the discharge more instantaneous.² One such simple device is the three-electrode trigger shown in Fig. 2.³

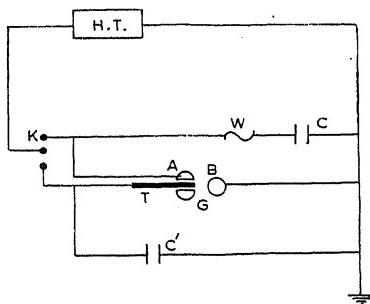


FIG. 2

By connecting the special key K to both the condensers C and C' they are charged simultaneously from the same H.T. to a voltage slightly less than the breakdown voltage V for the gap G between T and B. This prevents any large potential difference between T and A. The key is then connected to C alone and C is charged to the voltage V. C is then disconnected and K connected to C' alone, charging it to the same voltage V when the gap G between T and B breaks down, providing a path

for the breakdown of the gap between A and B in series with the main condenser C and the wire W.

In this arrangement, thus, the gap G is shorted by the triggering spark between T and B, the energy for this being supplied by the triggering condenser C'. The present investigation concerns with the change, if any, in the spectral nature of the explosion of the wire in the two cases. The gap width G in Fig. 2 could be adjusted so that breakdown occurs at any desired value of the voltage. Copper wires 1.5" in length and of different diameters are used. The spectrum is recorded in one explosion at atmospheric pressure using a Hilger medium quartz spectrograph. The main condenser C has a capacity of $176 \mu F$. and the triggering condenser C' $0.75 \mu F$. The voltages used are in the range 2.5 to 5.5 KV. The spectrum is first photographed using the arrangement in Fig. 2 when the spark gap G is shorted by the condenser C'. T is then disconnected from C' and connected to the bob A which then gives us an arrangement similar to that in Fig. 1 and the spectrum of the explosion is again photographed, keeping all other parameters the same as in the previous case. The spark gap G is now shorted by the main condenser C itself. It is found that the spectrum of the exploding wire remains unaltered in nature and intensity in both the above cases. Also the overall intensity of the explosion in the two cases, as measured by a photoelectric cell kept at a fixed distance from the wire, remains the same.

According to Chace,⁴ the discharge of the condenser through the wire takes place in two phases: (a) the vaporisation of the wire with explosive violence or transplosion, in which part of the energy stored in the condenser is used and (b) reignition, i.e., the restrike of the discharge through the metal vapour in which the rest of the energy stored in the condenser is spent. The energy spent in the first phase includes the energy used in breaking the gap G. On the basis of this theory, the present results could be explained if we assume that (a) the spectral intensity of the explosion is due to the second phase and (b) the energy spent in the first phase is negligible compared to that spent in the second phase, so that the latter is not affected whether the gap G is shorted at the expense of the energy from the main

condenser C or not. It is, therefore, not necessary to use any involved mechanism to trigger the gap G if one is concerned with the spectral study of the explosion.

Physics Department, K. GOPALA KRISHNAN.
University of Delhi, JUGAL KISHORE.
Delhi, April 20, 1961. K. RAJAGOPALAN.*

1. Anderson, J. A., *Astrophys. J.*, 1920, **51**, 37.
2. Kvartskhava, I. F., Pliutko, A. A., Chernov, A. A. and Bondarenko, V. V., *Soviet Physics*, 1956, **3**, 40.
3. Proc. of the Fourth International Conference on Ionization Phenomena in Gases, Uppsala, 1959, **1**, Part II-D.
4. Chace, W. G., *Exploding Wires* (Plenum Press), 1959, p. 7.

* Council of Scientific and Industrial Research, New Delhi.

ANION UPTAKE OF A CATION EXCHANGE RESIN

It is well known that the selectivity of an ion exchange resin is governed by the concentration of the external electrolyte solution. In equilibrium with dilute solutions, the resin is very selective. But the selectivity falls off as the concentration of the external solution is increased due to increased uptake of anion in case of a cation exchange resin and of cation in case of an anion exchange resin.

It is reported^{1,2} that in case of cation exchange resins, the Donnan uptake, as for example of chloride ion, is controlled by the type of cation present. The quantity of chloride uptake is determined by the crystallographic radius of the cation, its valence and charge, the uptake increasing with increase in radius as well as valence and charge. No data seem to exist indicating the type of variation observed in case of absorption of different anions by the same metal form of a cation exchange resin.

In this note, data have been presented for the crosslinked sodium form phenol sulphonate resin rods in equilibrium with four different anions (Cl^- , Br^- , CO_3^{2-} and Citrate $^{3-}$) in the concentration range 0.001 N to saturation at 30° C. The results relating to anion uptake expressed as a normality ratio (N , internal/ N , external) and density (g.ml. $^{-1}$) are presented in Fig. 1 and 2 respectively.

The anion absorption cannot be related to the characteristic parameters of the ions like radius, valence or charge. However, following points are of interest.

In the concentration range 0.001 to 0.01 N the resin is highly selective and excludes anions almost completely. As the concentration is increased to 0.1 N, it

picks up some anions, in any one case, the concentration not exceeding about 0.02 N.

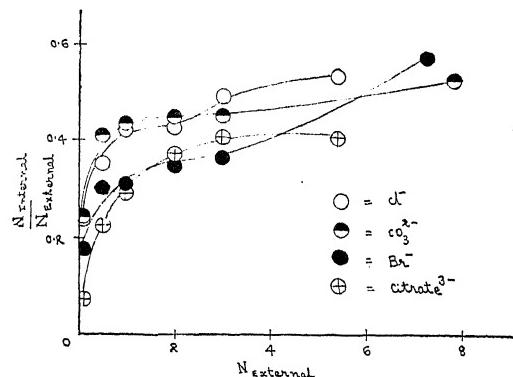


FIG. 1

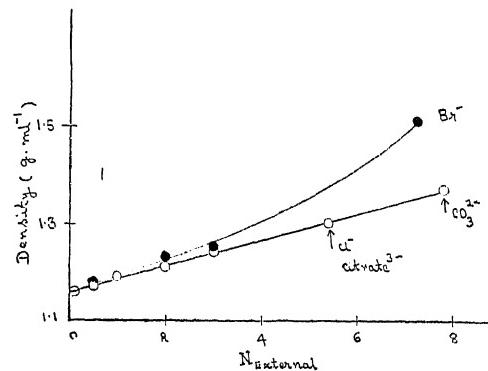
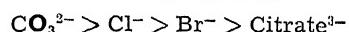


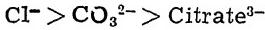
FIG. 2

2. In the range 0.1 to about 1.5 N, the order of anion absorption is as



At about 1.5 N, the Br^- uptake becomes less than that of Citrate $^{3-}$ and at nearly 4 N, it begins to rise continuously. Up to an external concentration of about 2.5 N, the order of anion absorption is roughly in keeping with the decreasing order of their equivalent weights.

3. At 2.5 N, Cl^- uptake rises above that of CO_3^{2-} and in the concentration range above 2.5 N, the order of uptake is as



with the Br^- absorption rising through the series.

The density data of Fig. 2 indicate that the resin absorbing CO_3^{2-} , Cl^- and Citrate $^{3-}$ severally has the same density values which rise gradually as the external concentration is increased. This is so, within the limits of experimental error,

due to the quantity of anion uptake being in the reverse order of their equivalent weights. As Br has the highest equivalent weight and roughly the same amount of absorption by the resin as the Citrate³ up to about 4 N, the density values are higher.

Physical Chem. Lab., K. JIJIE.
University of Madras, N. LAKSHMINARAYANAIAH.
Guindy, Madras-25, March 30, 1961.

1. Krishnaswamy, N., *J. Phys. Chem.*, 1955, **59**, 187.
2. —, *Curr. Sci.*, 1955, **24**, 234.

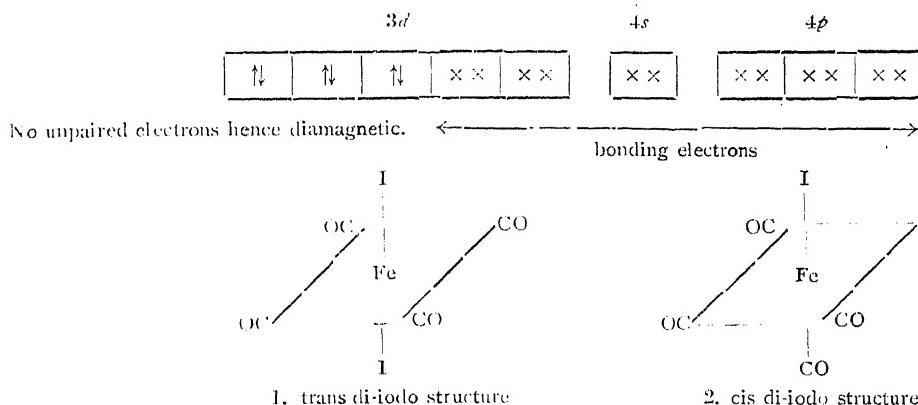
DI-IODO TETRACARBONYL IRON II

SOME physical measurements like infra-red absorption, magnetic susceptibility, etc., have been made with di-iodo tetracarbonyl iron II complex and are reported here. Solution of iodine in petroleum ether (60°–80° C.) was added

Infra-red absorption measurements on this compound can further distinguish between the following two structures: (1) trans di-iodo structure and (2) cis di-iodo structure.

If the compound has structure 1, only one peak is to be expected in the carbonyl region due to an overall symmetry of the molecule. For structure 2, more than one and up to four peaks can be observed if there is no overlapping. In fact, three sharp peaks have been observed. This appears to be a strong evidence for assigning a cis di-iodo structure to the compound. This assignment is also in agreement with the dipole moment measurements of Weiss² who found a finite value of 3.6 D; the trans di-iodo structure is expected to have a zero dipole moment.

Thanks are due to Prof. R. S. Nyholm, F.R.S., University College, London, W.C. 1, for his help and advice in the work.



to a solution of iron pentacarbonyl, $\text{Fe}(\text{CO})_5$, in the same solvent in an inert atmosphere. Some modifications were made to the earlier method.¹ Nearly 3 g. of pure and dry compound, $\text{Fe}(\text{CO})_4\text{I}_2$, was prepared.

The complex is virtually a non-electrolyte in nitrobenzene, A_m in 1.04×10^{-3} M solution being 1.2 mho. at 25°C . In powder form, the compound is diamagnetic, χ_g being -0.15×10^{-6} at 21°C . The molecular weight determinations in benzene show that it is monomeric. The infra-red absorption spectrum of the compound in Nujol suspension shows three sharp peaks at 2137 cm.^{-1} , 2088 cm.^{-1} , 2070 cm.^{-1} .

The compound is monomeric and diamagnetic indicating that it is clearly an octahedral spin-paired complex of iron II. Bivalent iron has an effective $3d^6$ configuration and hence a $3d^24s\ 4p^3$ hybridisation is involved in the formation of this compound giving an octahedral distribution of the ligands.

Dept. of Chemistry,
Ravenshaw College,
Cuttack, March 25, 1961.

D. V. RAMANA RAO.

1. Hieber and Bader, *Ber.*, 1928, **61 B**, 1717.
2. Weiss, *Z. anorg. chem.*, 1956, **287**, 213.

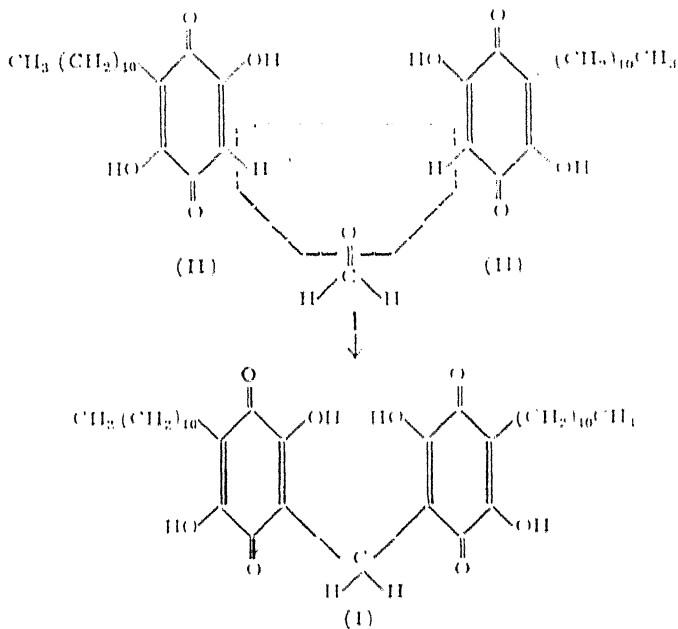
VILANGIN—A NEW CONSTITUENT OF *EMBELIA RIBES* AND *E. ROBUSTA*

MODIFIED extraction of the powdered dry berries of *Embelia ribes*¹ using purified methanol or dioxan yielded a new constituent, bright orange yellow in colour, m.p. $264\text{--}65^\circ\text{C}$. decomp. It is designated by us as "Vilangin," a name taken from the vernacular Telugu name, *Vayuvillanga* for *Embelia ribes*. Its molecular formula analysed to $\text{C}_{35}\text{H}_{52}\text{O}_8$, confirmed by Rast molecular weight of 610. It contained no alkoxyl groups and no oxide linkages. It is acidic in character and gave an intense brown ferric colour. Vilangin formed a yellow tetramethyl

ether and a pale yellow tetra-*o*-benzoyl derivative, indicative of four phenolic hydroxyl groups. It contained no alcoholic hydroxyl groups. On heating with *ortho*-phosphoric acid, anhydrovilanin was obtained, indicative of two hydroxyl groups which could be dehydrated readily. Vilanin could be regenerated by hydrolysis of anhydrovilanin using dilute potassium hydroxide. On acetylation by the acetic anhydride-pyridine method, two acetates were obtained: (1) an orange yellow tetra-*o*-acetylvilanin (which regenerated vilanin on hydrolysis) and (2) a red di-*o*-acetylanhdrovilanin, identical with the acetate obtained

From these considerations, vilanigin is assigned the structure, methylene-bis-(2,3-dihydroxy-4-undecyl-3,6-benzoquinone) (1). This constitution of vilanigin was further confirmed by an unambiguous synthesis using embelin (11) and its ready condensation with formaldehyde in neutral, acidic or alkaline solution. Although other dibenzoquinones are known, e.g., ooperuin and phoenicin,² vilanigin seems to be the first known example of a methylene-bis-benzoquinone occurring in nature.

Vilagin was found to occur in the dry berries of *Embelia robusta* also. Fuller details will be published elsewhere.



from anhydrovilangin. Reductive acetylation of vilangin gave two leucoacetates: (1) an octa- α -acetyl-tetrahydrovilangin (from which vilangin could be recovered by hydrolysis and subsequent aerial oxidation) and (2) a hexa- α -acetyl-tetrahydroanhydrovilangin identical with the reductive acetylation product of anhydrovilangin. These reactions indicated the existence of two quinone units which could easily be reduced and reoxidised. This is further supported by the formation of a tetroxime, a tetra-2 : 4-dinitrophenylhydrazone, a tetra-anil and a tetra-desoxy-tetramethylimino compounds. Further, oxidation of vilangin using alkaline permanganate gave *n*-lauric acid, whilst alkali fission gave α -ketomyristic acid, which are also products of similar reactions from embelin. These observations were further supported by the isolation of embelin by pyrolysis of vilangin.

Dept. of Chemistry, CH. BIREMAGANRAO RAO
Andhra University, VENKATICABURU
Waltair, April 29, 1961.

1. Waudby, C. J. H., *Pharm. J.*, 1888, **18**, 302; 1888, **19**, 601; Hettter, A. and Feuerstein, W., *Arch. Pharm. Berlin* 1900, **238**, 15; Kaud, R., Ray, A. C. and Dutt, S., *J. Indian Chem. Soc.* 1929, **6**, 577; 1931, **8**, 231; Nargund, K. S. and Bhide, B. W., *Ibid.*, 1931, **8**, 237; Asano, M. and Yamaguti, K., *J. Pharm. Soc., Japan*, 1940, **60**, 106; Asano, M. and Yamaguti, K., *Proc. Imp. Acad., Japan*, 1940, **16**, 36; Asano, M. and Hase, Y., *J. Pharm. Soc., Japan*, 1940, **60**, 650; Eisler, L. F. and Chamberlin, E. M., *J. Am. Chem. Soc.*, 1948, **70**, 71; Hassan, K. H. and Stedman, E., *J. Chem. Soc.*, 1931, pp. 2112.
 2. Posternak, T., Ruellius, H. W. and Tcherniak, I., *Helv. chim. Acta*, 1943, **26**, 2031; Lloyd, G., Robertson, A., Sankey, G. B. and Whalley, W. B., *J. Chem. Soc.*, 1955, 2163.

RAPID DETERMINATION OF MOISTURE CONTENT OF PARBOILED RICE BY AN IMMERSION METHOD

It was reported in an earlier communication that the bulk density of parboiled rice rose from 0.75 to 0.80 during drying while moisture decreased from 20 to 11%.¹ A method of relating the specific gravity of the rice grains as determined by an immersion method to its moisture content is described here.

Solvents of densities varying from 1.42 to 1.48 were prepared using mixtures of distilled kerosene (boiling between 170–200° C.) and chloroform. Both the solvents were saturated with water to eliminate the effect of the varying moisture content of the rice samples. Details of the composition of mixtures of varying specific gravity as determined with a specific gravity bottle at 28° C. are given in Table I. When pre-

TABLE II
Floating or sinking properties of rice samples in solvents of different densities

Moisture range %	Density of solvent mixture						
	1.48	1.47	1.46	1.45	1.44	1.43	1.42
19.5-18.0	F	F	F	F	F	F	S
17.9-16.5	F	F	F	F	F	F*	S
16.4-15.0	F	F	F	F	F	S	S
14.9-13.5	F	F	F	S	S	S	S
13.4-12.0	F	F	F	S	S	S	S
11.9-10.5	F	F	S	S	S	S	S

F—All 7 samples float; S—All 7 samples sink;

* 2 out of 7 samples sank in this mixture.

Parboiled rice of commerce has generally too high a moisture content for safe storage. Maximum permissible limits for moisture are now being contemplated and in enforcing these standards rapid methods of determining moisture content in rice are necessary, and a rapid test could be made by using the solvent mixture which gives the specific gravity of 1.45. If the commercial sample sinks in this mixture then the moisture content of the sample is lower than 13.5% which is a safe limit.

C.F.T.R.I., R. RADHAKRISHNAMURTY.
Mysore, May 1961. H. S. R. DESIKACHAR.
V. SUBRAHMANYAN.

TABLE I
Mixtures of chloroform and kerosene of different densities

Temperature 28° C.

Kerosene added to	1.50	1.25	1.00	0.75	0.50	0.25	0.00
20 c.c. of chloroform (ml.)							
Specific gravity of the mixture	1.42	1.43	1.44	1.45	1.46	1.47	1.48

served in glass-stoppered bottles at room temperature (25°–30° C.) even over a period of 30 days, these solvent mixtures did not show variations in the density. About 50 grains of the test sample of rice were added to small beakers containing these solvent mixtures. The specific gravity of the mixture in which the majority of the grains (90–95%) just sank was taken as representing the density of the grains. It was found that the grains in any sample exhibited the same density and behaved in the same manner. Only very few grains were lighter or heavier than the others.

The pattern of results obtained by testing five different commercial samples of 'Ratnachudi' variety and two samples of 'Kar' variety rice at various moisture levels ranging from 19.5 to 10.5% are presented in Table II. The moisture content of the rice samples was determined by drying at 105° C. for 18 hours in an electric oven.

Results presented in Table II indicate that these solvent mixtures could be used with fair certainty to determine rapidly by the simple immersion method the moisture content of rice samples within a range of 1.5%, and could be employed as a quick test when automatic moisture meters are not available.

FERTILIZER VALUE OF DICALCIUM PHOSPHATE

Dicalcium phosphate, prepared by treatment of rock phosphate with hydrochloric acid, offers a considerable scope of being used as a substitute for superphosphate, manufacture of which involves the use of sulphuric acid. The material has been used as a phosphate fertilizer by many workers and the general trend of the results show that it is very often as good as superphosphate. Field experiments carried out by present authors confirm the previous findings as the following results will show.

TABLE I
Yield of wheat and maize in Delhi Soil
(In mds./acre, average of six replications)

Treatment	Wheat (N.P.710)		Maize (Yellow 2)	
	(1957-58)	(1958-59)	(1958)	(1959)
No Manure ..	8.92	9.64	4.08	9.32
40 lb. N/acre ..	14.09	15.71	7.58	17.75
40 lb. + 80 lb. P ₂ O ₅ as super-phosphate/acre	19.28	21.27	9.18	15.78
40 lb. + 80 lb. P ₂ O ₅ as dicalcium phosphate/acre	18.28	16.99	8.47	12.97
C.D. at 5% ..	2.69	9.09	0.88	8.07

The results indicate that P_2O_5 , when applied either in the form of monocalcium phosphate or dicalcium phosphate is equally suitable on the neutral and alkaline soils.

Indian Agri. Research Institute, A. K. RISHI.
New Delhi, March 21, 1961. V. ISWARAN.

-
1. Gilbert, B. E. and Pember, F. R., *Agri. Expt. Sta. Bull.*, 1936, 256, 24.
 2. Green, J., *Mont. Agri. Expt. Sta. Bull.*, 1958, 356, 31.
 3. Idhani, M. A. et al., *Proc. 42nd Ind. Sci. Cong.*, 1955, 3, 364.
-

DISCOVERY OF MARINE, PERMO-CARBONIFEROUS IN THE WESTERN RAJASTHAN

WHILE carrying out mapping of the pre-Jurassic sediments in the western Rajasthan peneplain this year, the authors encountered richly fossiliferous sediments of Permo-Carboniferous age. The occurrence of it is being reported for the first time. The fauna yielded by these sediments indicates a marine environment of deposition.

Exposed near the village Badhaura ($27^{\circ} 18' : 72^{\circ} 17'$) in the Jodhpur District, this formation has been provisionally designated as the "Badhaura Formation".

It is coincidental that many earlier workers¹⁻⁴ have reported certain 'Permo-Carboniferous glacial deposits'—the so-called 'Bap-Beds'—from around the same area. It should be, nevertheless, noted that these earlier

reports refer, exclusively, to the terrestrial deposits, their age being fixed on the basis of the lithological and environmental similarity to the 'Boulder Beds' of Talchir, 'Boulder Beds' of Salt Range, etc., unsupported by fossil evidence. The Bap Boulders, consisting of a wide assortment of boulders of various sizes and different rock types, both igneous and metamorphic, bear some grooves which are suspiciously similar to the effects of glacial transportation.

The general stratigraphy of the area showing the position of the *Badhaura Formation* therein, is given in Table I.

Bap Boulders, referred to earlier, and the "bouldery" yellow sandstone/grits of the Badhaura Formation are, in our opinion, broadly contemporaneous; the former representing glacial drift near the shore and the sporadic boulders in the sandstones/grits of the latter, being probably ice-rafted.

The fauna collected from the Badhaura Formation consists of:—

- (1) *Products* sp.; (2) *Spirifer* sp.; (3) *Spiriferina* sp.; (4) *Derbyia* sp.; (5) *Lingular* sp.; (6) *Straparolius* sp.

There are many other gastropods, lamellibranchs, cephalopods and plant stems; the detailed identification of the entire fauna and flora is in progress.

The Badhaura Formation probably represents the eroded remnants (mostly overlapped by the later Mesozoic deposits—"Mayakor Formation")

TABLE I

<i>Mayakor Formation</i>	10 m.	Brown to black, compact, ferruginous and yellow friable sandstone with fossil wood	Equivalent to the <i>Lathi Formation</i> (Mid-Jurassic)
		UNCONFORMITY	
<i>Badhaura Formation</i>	20 m. plus	Yellow sandstone and reddish brown clays with hard band of brown ferruginous sandstone containing lamellibranchs and petrified plant stems, with a highly calcareous sandstone at the base studded with casts of brachiopods	
		Yellow, compact bouldery sandstone and grits inter-bedded with dark brown, concretionary sandstone containing brachiopods, lamellibranchs, gastropods, cephalopods and fossil wood. These sandstones and grits are bouldery, containing pebbles and boulders of granite and other igneous and metamorphic rocks	
		Dark grey and yellow clays with pebbles and boulders of granite and other igneous rocks	Permo-Carboniferous
		UNCONFORMITY	
<i>Phalodi Limestone</i>	90 m.	Light to dark grey, cherty dolomitic limestones, dolomites and chert beds	
		UNCONFORMITY	
<i>Phalodi Sandstone</i>	150 m.	Red, fine to medium grained, illsorted, highly current bedded and friable sandstone with minor clays and bands of gypsum	Palaeozoic (?)
		UNCONFORMITY	
<i>Tallian Basement</i>	..	Granites and Rhyolites	Malani-Suite (?)

of the sediments deposited in a vast Palaeozoic basin, which could reasonably be thought of as the eastward continuation of the arcuate (convex to south) Persian Gulf Basin.

It is concluded that the Mesozoic and younger sediments of Western Rajasthan are probably underlain by an appreciable thickness of Palaeozoic sediments, thereby, enhancing the hydrocarbon prospects of the area.

Geologists, Oil and Natural J. S. MISRA.
Gas Commission, B. P. SHRIVASTAVA.
Dehra Dun, June 16, 1961. S. K. JAIN.

1. Oldham, R. D., *Rec. Geol. Surv. Ind.*, 1886, **19**, 123.
2. —, *Manual of the Geology of India*, 1893.
3. La Touche, T. H. D., *Mém. Geol. Surv. Ind.*, 1902, **35**, 33, 34.
4. —, *Ibid.*, 1911, **35**, 24, 91.

ABOUT FLUID INCLUSIONS IN BARITE FROM PULIVENDLA

WITH the object of finding the temperature of formation of barite deposit and the nature of ore-forming fluid, numerous fluid inclusions in barite were examined and their temperature of homogenisation was measured by the method developed by Ermakov (1950).

Barite occurs as fissure veins and replacement veins (Coulson, 1933) in the Vempalle limestone and associated trap (diabase) sills of the Papaghni Series, in the Cuddapah System. Numerous shear fractures and dislocation planes are usually found at the contact of Vempalle limestone with the trap sills. The best quality of barite occurs between two trap sills, often in large quantities (Krishnan, 1953). At places barite is associated with very thin veins and stringers consisting of pyrite, chalcopyrite, magnetite and malachite. In such places barite invariably acquires pink, green and grey colours.

The microscopic examination of thin plates of barite shows numerous fluid inclusions. They have various shapes—tube-like, mostly oriented along (011), and ellipsoidal, crudely oriented along (110) of the crystals. In addition, there are large numbers of irregular-shaped inclusions arranged along the boundaries of crystals. Apart from these primary inclusions, many irregular inclusions are arranged along the parting planes and other fine fractures. These are secondary inclusions.

The fluid inclusions in barite are mostly one phased (liquid only), rarely two phased (liquid + gas) and occasionally three phased (water + liquid CO₂ + gas). In most of these, gas occupies

about 10% of the volume of inclusion but liquid CO₂ at 18° C. occupies about 20% of the volume of inclusion. The primary inclusions contain all the three types but the secondary ones are invariably one phased (liquid) only.

The temperature of homogenisation in primary inclusions (57 determinations) range from 125° to 130° C. but the secondary inclusions have the temperature of homogenisation as 65° to 50° C.

A qualitative microchemical analysis of the water extract of fluid inclusions from pink barite indicated the presence of the anions Cl⁻, HCO₃⁻, SO₄²⁻ and the cations Ca²⁺, Mg²⁺, Fe²⁺, Na⁺. The water extract was distinctly alkaline having pH = 8 at 20° C.

The temperature of homogenisation of inclusions of ore-forming fluid indicates that barite was formed in a low temperature hydrothermal phase where the temperature was of the order of 130° C. It is probable that the trap introduced much of the barite in solution (Krishnan, 1953). The chemical analysis of fluid inclusions indicates the following possible combination of easily soluble salts which can be present in water solution in the fluid inclusions: chlorides—NaCl, CaCl₂, MgCl₂, FeCl₂; bicarbonates—Ca(HCO₃)₂; sulphates—CaSO₄, MgSO₄; probably the chlorides have played an important role in the formation of barite. It is established that the solubility of barite in water is greatly increased in the presence of NaCl. However, the chemical environment during the formation of barite can only be judged by investigating the fluid inclusions in the associated minerals like quartz, calcite and malachite, etc.

Department of Geology, Y. G. DEKATE.
Nagpur University,
Nagpur, April 10, 1961.

1. Coulson, A. L., *Mém. Geol. Surv. Ind.*, 1933, **64**, Part I.
2. Ermakov, N. P., *Issledovaniia mineralobrazuyushchikh rastvorov*. Izd. Kharkovsk. Ooniversiteta (In Russian), 1950.
3. Krishnan, M. S., *Bull. Geol. Surv. Ind.*, 1953, Series A, No. 5.

A MODIFIED MEDIUM FOR THE PRODUCTION OF PERTUSSIS VACCINE

SEVERAL media both solid and liquid are used for the production of pertussis vaccine. A simple solid medium useful for mass production of vaccine is described below.

To casein hydrolysate (Sokhey *et al.*, 1950) were added 2·5% agar powder, 0·5% activated charcoal (Nuchar) and steamed for 15 minutes. The medium was then distributed in Roux

bottles and sterilised at 115° C. (10 lb./sq. inch) for 15 minutes. The bottles were taken out of the steriliser, cooled to about 60°–70° C. and 10·0% sterile yeast dialysate containing 5 units per c.c. crystalline penicillin G. sodium were added, mixed well and sloped. The bottles were then seeded with a heavy inoculum containing 2 units per c.c. of crystalline penicillin G. sodium and incubated at 37° C. for 3 days.

Under the conditions of work obtainable in this Institute, the rate of contamination observed with this medium was considerably lower than with other commonly used media. The yield of the vaccine was also fairly high, being about 200 c.c. (containing 40 billion org/c.c.) per bottle.

Haffkine Institute,
Bombay-12,
May 4, 1961.

M. K. HABBU.
H. K. MHATRE.
G. M. GOVEKAR.

1. Sokhey, S. S., Habbu, M. K. and Bharucha, K. H.,
Bull. World Hlth. Org., 1950, 3, 25.

PINK AND GREY GRANITES OF HYDERABAD

Two distinctive types of granites, namely, pink and grey, from Hyderabad (Osmania University area : lat. 17° 25' and long. 78° 31½'), have been studied in detail and the results relating to modal analyses are given in Table I. G and P indicate grey and pink granites respectively.

TABLE I
Modal Analyses

No.	Quartz	Potash Fels.	Perthite	Plagio- clase	Total fels.	Biotite & Fe ores	Other Access- ories
G ₁	36·10	49·87	4·31	2·11	56·29	6·47	0·89
G ₂	41·81	41·70	9·90	1·47	53·07	4·72	0·55
G ₃	38·30	40·42	15·25	0·72	56·59	4·34	1·23
G ₄	44·68	34·24	17·37	4·32	55·93	0·36	0·09
G ₅	38·21	36·57	11·82	4·22	52·61	8·75	..
Average	38·82	40·56	12·73	2·57	54·90	4·93	0·51
P ₁	27·62	42·21	20·87	5·39	68·47	2·99	0·86
P ₂	24·77	36·46	29·34	1·88	67·68	7·44	0·10
P ₃	21·12	53·61	18·96	1·46	74·03	4·15	0·70
P ₄	28·21	67·13	..	..	67·13	3·93	0·71
P ₅	27·84	35·93	24·19	4·55	64·67	7·53	0·66
Average	26·91	46·07	18·67	2·66	68·40	5·21	0·61

The grey granites show less of potash felspars and more of quartz, while the pink granites show an increase in potash felspars and a decrease in quartz, with other accessories remaining almost the same. In most cases perthites show a great variation in amount as well as the mode and extent of intergrowth. They vary from 4% to as much as 30% in content and include ordinary, microcline and antiperthites. Pyroxenes and amphiboles are absent

while biotite and other associated accessory minerals are present. The presence of some blades of muscovite in the case of pink granites suggests the advanced stage of transmutation of felspars. The petrographic study suggests that the grey granites are derived from the pre-existing Dharwar Schists and the pink granites are the later phase of the granitised grey granites. This is in conformity with observations made earlier by Raja (1959)¹ in this laboratory.

The elastic properties as determined by employing the wedge method (1944)² for the same 10 granites as listed above are given in Table II.

TABLE II
Elastic Constants

No.	<i>g</i>	<i>p</i>	<i>V_L</i>	<i>V_T</i>	<i>n</i>	<i>Y</i>	<i>σ</i>
G ₁	0·33	2·59	6·1	2·8	1·98	5·45	0·373
G ₂	0·34	2·58	6·1	3·0	2·30	6·17	0·340
G ₃	0·39	2·80	6·1	2·8	2·00	5·47	0·368
G ₄	0·35	3·18	6·2	2·8	2·04	5·59	0·370
G ₅	0·32	2·72	6·7	3·3	2·77	7·44	0·345
P ₁	0·52	2·55	5·9	2·4	1·52	4·23	0·396
P ₂	0·49	2·58	5·7	2·7	1·98	5·34	0·352
P ₃	0·62	2·86	6·0	2·1	1·10	3·15	0·437
P ₄	0·54	2·58	5·4	2·4	1·51	4·15	0·374
P ₅	0·49	2·61	5·7	3·2	2·54	6·54	0·287

In the above table, grain size *g* is in mm., density *p* is in gm./c.c., longitudinal velocity (*V_L*), and torsional velocity (*V_T*) in Km/sec., Young's modulus *Y* and rigidity modulus *n* in 10^{11} dynes/cm.² and *σ* is Poisson's ratio.

The results relating to elasticity stand nicely correlated with the geological features. In the case of pink granites the velocities are generally less than in the grey granites. This is because of the coarse grained nature and the presence of felspars in abundance in pink granites.

Geology Department, S. BALAKRISHNA.
Osmania University, M. RAGHAVA RAO.
Hyderabad-7, May 31, 1961.

- Raja, N., "Studies in granites of Hyderabad," *Ph.D. Thesis* submitted to the Osmania University, 1959.
- Bhagavantam, S. and Bhimasenachar, J., *Proc. Ind. Acad. Sci.*, 1944, 20 A, 298.

A MICRO-CHAMBER FOR INCUBATION OF PLANT SECTION AND ITS GROWTH RATE MEASURING

THE principle of a first plant section test, namely, the Avena coleoptile one elaborated by Bonner,¹ was so useful and convenient for the examination of the biological activity of several naturally occurring growth substances as well as synthesized compounds that, now, there are a great number of modifications of it, according to the plant genus used, specific properties of substance tested, etc.²

All tests embraced by this group depend on a measuring of the length of section reached after suitable period of time. However, the longitudinal expansion of coleoptile or hypocotile usually is not constant but changes with the time³; it is also well known, that individual differences exist between plants of the same kind, which results in variability of growth velocity of sections cut from them. So, it is evident that in some cases, especially when one wants to study the effects of two or more compounds applied one after another, there is need to measure the growth rate of individual section during the whole time of the experiment.

Fortunately, the problem has been more or less solved by a few methods,⁴ and it appears that one of the best methods is the photographic technique proposed by Michel.⁵ In Michel's procedure plant sections are placed in rectangular holes cut out in discs of polyethylene sheet, floating on the surface of the solution. At the beginning of the experiment, and after suitable periods of time, petri dishes with the samples are photographed using a speed-light as the light source. An enlarged image of a finished film is projected on a sheet of paper, the ends of the sections are marked with a sharp pencil and then distances between the marks are measured with a suitable ruler; one can also make direct measurements of sections using a transparent ruler. Owing to the polyethylene disc separating each section from the other, there is no difficulty in identifying the sections, and to make it easier, in one of the holes, a standard polyethylene section is placed for reference purposes.

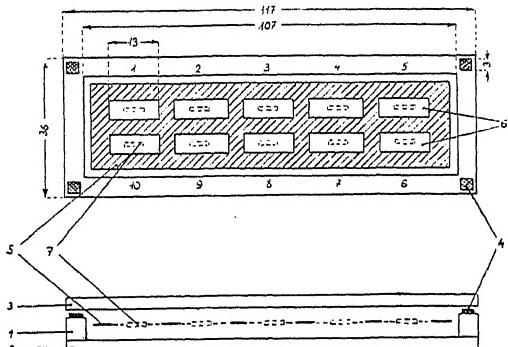


FIG. 1

In this laboratory there was need to measure growth rates of a great number of individual hypocotyl sections of *Sinapis alba*, *Linum usitatissimum*, etc. Most satisfactory results have

been obtained by the author with a modified Michel's technique, especially with respect to incubation conditions: sections were not incubated in petri dishes but in a micro-chamber built up from plexiglass or another transparent, chemically inert plastic (see Fig. 1).

This chamber comprises the rectangular, 6 mm. thick frame (1) glued together with the basic plate (2), and from the loose top plate (3), resting upon four small supports (4), placed at the corners of the frame. To the sink so formed, surrounded by the frame, a suitable volume (usually 10 ml.) of water or tested solution is poured, and plant sections are placed in rectangular hollows⁶ cut in a sheet of polyethylene strip,⁵ floating on the liquid surface; to avoid a mistake in identification of sections the hollows are numbered.

The measurements of growth rates are quite easy and may be done either in the original photographic way described by Michel (especially if there are a great number of repetitions and substances tested simultaneously) or may be done directly, using a microscope with a micrometer scale, without taking sections from the chamber. The latter way, owing to small dimensions of the chamber and linear arrangement of the sections examined, is very rapid and the right reading of lengths of all ten sections may be done in 30-40 seconds.

Department of Plant Physiology, J. S. KNYPL,
University of Lodz,
Poland, May 18, 1961.

1. Conner, J., *J. gen. Physiol.*, 1933, **17**, 63.
2. Linser, H., Kiermayer, O., *Methoden zur Bestimmung pflanzlicher Wuchsstoffe*, Springer-Verlag, Wien, 1957.
3. Bonner, J. and Foster, R. J., *J. exptl. Bot.*, 1955, **6**, 293.
4. Bennet-Clark, T. A. and Kefford, N. P., *Ibid.*, 1954, **5**, 293.
5. Michel, B. E., *Proc. Iowa Acad. Sci.*, 1956, **63**, 287.

ON PROLONGING THE LONGEVITY OF THE DOG-TICK RHIPICEPHALUS SANGUINEUS LATR. AFTER OVIPOSITION

Most of those who have hitherto observed the life-history of this common dog-tick (Christophers, 1907; Patton and Cragg, 1913; Hooker, Bishopp and Wood, 1912; Regendanz and Reichenow, 1931) agree that the female tick lives only for 4-5 days after completion of oviposition. Of the several female ticks observed by Nuttall (1915), one lived up to 19 days, one for 15 days, 4 for 6 days, 2 for 5 days and the rest died in 2-3 days except some which lived

only for one day after oviposition. Lombardini (1950) noticed one female tick dying on the 9th day and the rest in his collections dying in 4-5 days after oviposition.

The average number of days the exhausted females survived after oviposition in Sapre's (1945) observation was 6 days in India at 22° C. and 7,500 feet altitude, conditions altogether different from those obtainable in this area.

The present author during the course of two and a half years of research work with this tick has not seen any female tick living for more than five days after finishing oviposition under conditions prevailing in this part of India.

As far as the author is aware there is no report of a female tick reinfesting its host for one more blood-meal after completing the normal oviposition. This might be because, the activity of the tick is completely lost and as Stella (1942) has stated, hardly any trace of the ingested blood remains in the tick by the time it finished oviposition.

This is to report on the success of the author in making a good number of such exhausted and senile female ticks not only live up to a significantly long period after oviposition, but be fit for one more infestation and further experimentation. The technique employed was as follows.

With the aid of a micrometer syringe and glass needle enabling to inject a very minute quantity of any medium, a solution of sugar (commercial) was injected into the body cavity of each of a set of female ticks one day after oviposition had stopped. (These had fed on dogs before oviposition.) Each female of a second set from the same stock as above was injected with the same quantity of distilled water. A third set of females belonging to the same stock, as the above two sets, was kept without any injections.

It was observed that the second and third sets of ticks died their normal death in 3-5 days except for one in the second set which lived one day more. But the majority in the first set which had received sugar solution lived up to 31 days. Four ticks in this set lived for 15 days and one only for 4 days. The author has not so far come across any report on the success of maintaining alive such exhausted ticks after the normal period of life since oviposition. The author feels that this method of prolonging the life of ticks by injections may possibly open out new ways and means of accomplishing physiological and pathogen-transmission studies which hitherto had to contend against the immense

difficulties involved in artificial feeding of the tick.

Details regarding the dosage of injections and the results of further experiments will be published later.

The author expresses his sincere gratitude to Prof. P. K. Menon for his help and guidance.

Department of Zoology, P. D. ACHAN,
Presidency College,
Madras-5 (India), May 18, 1961.

1. Christophers, S. R., "Sexual cycle of *Leucocytozoon canis* in the tick," *Scient. Mem. by Officers of Med. and Sanit.*, Department of Government of India, 1907, No. 28.
2. —, "Piroplasma canis and its life-history in the tick," *Ibid.*, 1907, No. 29.
3. Patton, W. S. and Cragg, F. W., *A Text-Book of Medical Entomology*, Christian Literature Society for India, London, Madras and Calcutta, 1913.
4. Nuttall, G. H. F., *Parasitology*, 1915, 7, 408.
5. Hooker, W. A., Bishop, F. C. and Wood, H. P., *Bull. U.S. Bur. Ent.*, 1912, No. 106, 239.
6. Regendantz, P. and Reichenow, E., *Arch. U. Tropenhyg.*, 1931, 35, 252. (only Biol. abst. seen).
7. Stella, E., *Arch. Zoo Torino*, 1942, 30, 155.
8. Sapre, S. N., *Ind. J. Vet. Sci.*, 1945, 14, 111.
9. Lombardini, G., "Observationi biologische ed anatomiche sul *Rhipicephalus sanguineus*. Latr." *Redia*, 1950, 35, 173.
10. Hoogstraal, H., *African Ixodidae*, 1956, 1, 686.

PRELIMINARY TRIALS IN THE CONTROL OF THE MAIZE BORERS, *CHILO ZONELLUS* (SWIN.) AND *SESAMIA INFERENS* (WLK.), IN RAJASTHAN

AMONG the various pests seriously affecting Maize, an important food crop of south-eastern Rajasthan, the stem-borers, mainly of two different species, viz., *Chilo zonellus* (Swin.) (*Lepidoptera*—Fam: Pyralidae) and *Sesamia inferens* (Wlk.) (*Lepidoptera*—Fam.: Noctuidae) are the major culprits concerned. Srivastava,¹ (1959) has reported these two species from Rajasthan, but found no satisfactory control by the application of insecticides. On the other hand, Mukherji,^{2,3} Gupta and Avasthi,⁴ and Agarwala and Prasad,^{5,6} report effective control of such borers on sugarcane by the use of some of the modern insecticides, such as Gammexane and Endrin. Preliminary trials of insecticidal sprays on this crop were, therefore, undertaken in 1960 at the Rajasthan College of Agriculture, Udaipur, and the present note reports the results obtained in the control of the pests by the use of sprays of Endrin and DDT.

An experiment on the usual randomized statistical design was devised on 1/6th of an acre of a crop of Hybrid Maize. There were

4 blocks each with two treatments and one control, each being thus replicated 4 times. The following two insecticides were applied in the form of a mist-spray : (1) "Endrin 20" EC in the form of 0.02% emulsion spray and (2) DDT 50% WP applied as 0.25% suspension. The first treatment was given in the last week of July, i.e., about 3 weeks after sowing, the second in the second week of August and the third in the last week of August.

TABLE I

Percentage of infestation in plant counts for different treatments

Treatment	Plot No.	Number of plants in plots		Percentage of infestation	
		Total No.	Plants infested	Per plot	Mean of four
Endrin 0.02%	1	138	10	7.24	5.68
	2	170	5	2.94	
	3	146	9	6.16	
	4	94	6	6.38	
DDT 0.25%	1	149	24	16.10	12.92
	2	142	22	15.49	
	3	168	23	13.69	
	4	156	10	6.41	
Control	1	143	25	17.48	15.52
	2	175	31	17.71	
	3	87	9	10.34	
	4	163	27	16.56	

C.D. at 5% level — 6.12.

For estimating the percentage of damage (Table I), every plant was carefully examined immediately after harvest in the second week of October, by stripping it to locate the exit holes, and later by splitting it for taking notes of the details of damage and the presence of live borers. In many instances, plants were found attacked at more than 3 places, while in a few cases, as many as 9 or 10 separate tunnels along with 6 or 7 borers were noticed.

From Table I, it is seen that both Endrin at 0.02% and DDT at 0.25% concentrations have had the effect of reducing the borer infestation. In the case of Endrin, however, the results are clearly significant, whereas in the case of DDT the figures are by no means significant.

Our sincere thanks are due to Shri Y. Rama-chandra Rao for his valuable suggestions and Dr. A. Rathore, Principal, Rajasthan College of Agriculture, Udaipur, for laboratory facilities kindly provided.

K. S. KUSHWAHA.

J. C. SHARMA.

L. S. SHARMA.

Dept. of Zoology and Entomology,
Rajasthan College of Agriculture,
Udaipur, March 25, 1961.

- Srivastava, B. K., *J. Bombay Nat. Hist. Soc.*, 1959, **56**, 665.
- Mukherji, B. K., *Ann. Rept. of Sugarcane Res.*, Work conducted in Uttar Pradesh for the year 1948-49, 1950.
- , *Ibid.*, 1949-50, 1951.
- Gupta, B. D. and Avasthy, P. N., *Ind. Sug.*, 1954, **4** (3), 387.
- Agarwala, S. P. D. and Prasad, S. N., *Ibid.*, 1951, **4** (9), 445.
- and —, *Ibid.*, 1955, **4** (10), 502.

A RARE SEROTYPE OF *PASTEURELLA MULTOCIDA*, CAUSING PNEUMONIA IN SHEEP IN INDIA

PRELIMINARY results of studies on the prevalence of various serotypes of *Pasteurella multocida* in different species of animals and birds in India were published in an earlier communication¹ from this laboratory. As many as 25 strains isolated from cases of enzootic pneumonia in sheep in the States of Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir were serologically typed when 12 cultures were found to belong to Roberts' type I (Carter's type B), 2 to Roberts' type IV (Carter's type D) and eleven isolates could not be accommodated into any of the recognised serogroups I to IV of Roberts² and the newly delineated type V of Hudson.³ All these strains could not be typed as they were avirulent to mice and lacked the capsular polysaccharide and somatic lipopolysaccharide fractions that were shown to determine type-specificity.

Recently a strain (CS) of *Pasteurella multocida* of low virulence was isolated in pure culture from cases of pneumonia in sheep at one of the state farms at Chinnasalem in Madras. Complete consolidation of apical and cardiac lobes was a cardinal feature and the condition led invariably to death of the affected sheep within three days. Pneumonic lungs were screened for the presence of a virus with entirely negative results. The unusual features exhibited by the CS strain of *P. multocida* were (1) fermentation of maltose but not xylose and arabinose, (2) ability to elaborate a soluble haemolysin active against erythrocytes of sheep but not any other species, (3) absence of haemolysis on blood agar plates containing 5% (v/v) of horse, ox, sheep, goat, fowl, pigeon, rabbit, guinea-pig and mouse blood, and (4) possession of Forssmann heterophile activity reported earlier only with cultures isolated from rabbits.⁴⁻⁷

In the indirect bacterial haemagglutination and haemolysis tests, extracts prepared from the CS strain by autoclaving at 15 lb. pressure for 30 minutes either broth or yeast-extract agar-

grown cell suspensions (adjusted to match in opacity to tube 2 in the Burroughs Wellcome standard scale) gave a titre of 1 : 320 and 1 : 1280 respectively, with standard sera representative of type III but only 1 : 40 when tested against type II.

The type-specificity of the soluble antigen was demonstrated in the corresponding inhibition tests recently developed in this laboratory. Autoclaved extracts diluted to 1:32 to 1:64 inhibited agglutination and lysis of sensitised erythrocytes by type III antisera. In the complement-fixation technique carried out on the lines of Rice et al.,⁸ titres of 1:64 and 1:4 were elicited against type III and type II antisera, respectively. The immunological homogeneity was shown in gel-diffusion tests when a single line appeared on Ouchterlony plates when extracts were diffused against homologous and standard type III whole-cell or crude extract rabbit antisera.

The strain could not be typed by Roberts' passive mouse protection test as it failed to kill mice except when given as meat broth cultures. It killed pigeons within 4 days but proved avirulent to rabbits.

Pneumonia was successfully induced in susceptible lambs when they were infected by intranasal, intratracheal and subcutaneous routes and *P. multocida*, type III, was recovered from pneumonic lungs of experimentally infected lambs, thus, fulfilling the modified Henle-Koch's postulates. Intravenous inoculation of cultures proved fatal to adult sheep within 12 hours. A tetravalent oil-adjuvant vaccine has since been developed for field trials on active immunisation of sheep on the affected farms.

This is the first report of primary pneumonia in sheep due to *P. multocida*, type III. The isolation of yet another immunotype adds to the complexity of the problem of biological prophylaxis against pasteurellosis in sheep. This serotype had not been isolated earlier, save from a cat,¹ in India.

Pasteurella Laboratory,
Division of Pathology and
Bacteriology,
Indian Vet. Res. Inst.,
Mukteswar (Kumaon),

AND
K. ANANTAPADMANABHAN.
Veterinary Disease Investigation
Officer (Sheep and Goats),
Ranipet (Madras State), December 21, 1960.

1. Dhandia, M. R., *Ind. Vet. J.*, 1959, 36, 327.
2. Roberts, R. S., *J. Comp. Path.*, 1947, 57, 262.

3. Hudson, J. R., *Bull. Off. Int. Epiz.*, 1954, 42, 266.
4. Boyd, W. C., *Tabula Biologica*, 1939, 17, 113.
5. Streng, K. O., *Acta Pathol. Microbiol. Scand.*, Suppl., 1938, 37, 493.
6. Sievers, O., *Ibid.*, 1938, 37, 458.
7. —, *Ibid.*, 1939, 16, 44.
8. Rice, C. E., Beauregard, M. and Maybee, T. K., *Canad. J. Comp. Med.*, 1955, 19, 329.

OBSERVATIONS ON THE ROTIFERS FROM SHALLOW PONDS IN DELHI

ALTHOUGH rotifers are valuable food of carp fries, only a few workers have attempted to study their ecology; the most notable ones are Anderson¹ and Edmondson and Hutchinson.² Alikunhi, Chaudhuri and Ramachandran³ have observed the quantitative variations of rotifers in a few nursery tanks in Cuttack, though annual population study was not attempted. Das and Srivastava,⁴ during the course of a general study of the plankton of a tank in Lucknow, have made a few remarks on the rotifers present.

The present note deals with the periodicity, species composition and diurnal migration of rotifers from five fish ponds situated in different blocks of Delhi. The tanks studied are Roshanara tank, Indranagar tank, Naini lake, Shahdra Stocking tank and Shahdra Nursery tank, of which the last was dry in June and July. The observations are based on the analysis of data from October 1958 to September 1959.

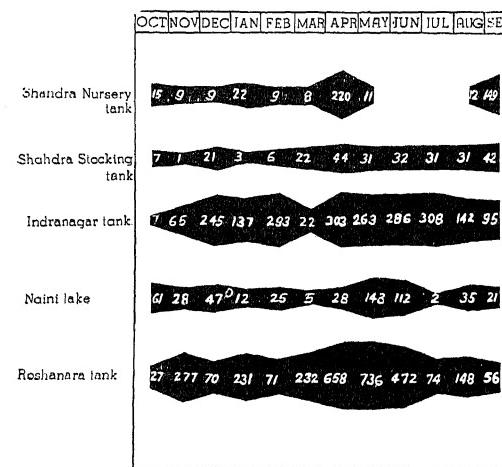


FIG. 1. Quantitative variations in rotifer population in different tanks.

The quantitative variations in the rotifer populations are represented in Fig. 1, which is prepared after Lohmann's Spherical Curve Method cited by Birge and Juday.⁵ The numbers indicated in Fig. 1 represent the population, as organisms per litre, which is an average

of two fortnightly samples. Generally, a major pulse of rotifers was discernible in all the tanks in the summer months of April to July, though in Roshanara tank and Indranagar tank they showed minor pulses in different months. Thus, a summer periodicity may be attributed to the rotifers in Delhi waters. Pennak,^{6,7} from his observations has concluded that there is no seasonal periodicity in North American rotifers. Wesenburg-Lund⁸ has shown that their seasonal variations in Danish waters are not very marked. The present observations point to the occurrence of a summer periodicity in rotifers. It is likely that in tropical waters they may show a summer maximum, but more extensive work is needed to confirm this.

A notable feature of the species composition of the rotifers from the ponds in Delhi is the simultaneous occurrence of two or more species of the same genus in a single collection. For instance, it was seen that *Brachionus* was represented by more than two species, even up to four, in many samples and it was the only genus observed to have such a species composition. Pennak⁹ has observed that in a few genera of rotifers, two species of the same genus appear occasionally in a single sample. According to the present author, it is for the first time that more than two species of the genus *Brachionus* is reported from a single collection. The different species that have entered into such a species composition are *B. calyciflorus* Pallas, *B. falcatus* Zacharias, *B. quadridentatus* Hermann and *B. bidentata* Anderson. Another example is the genus *Filinia* which showed two species in a single collection.

Pennak⁹ has noted that whenever two species of the same genus are present, one is almost always more abundant than the other. But an analysis of the present data does not reveal any significant dominance of one species over another. Moreover, there were instances when more than two species of *Brachionus* had appeared at one time; and in those cases two or sometimes three species were seen to exist in almost equal number. The food habits of different species of *Brachionus* are not well understood, but it is apparent from the species composition that inter-specific competition for food in this genus is very little.

The total number of species of plankton rotifers so far recorded from the tanks under study and also from the survey of 25 other tanks in Delhi State, is thirty-two. Either *Keratella valga* f. *tropica* Apstein or the (different) species of *Brachionus* always showed numerical superiority over the other rotifers. This feature appears

to be characteristic of the tanks in Delhi, which have pH always above 8.0.

George¹⁰ has made observations on the diurnal migration of rotifers, which differ from the observations of earlier workers. In Roshanara tank, the maximum rotifer population was noted at the surface at 10 a.m. while in Naini lake it was at 4 p.m. Vaas and Sachlan¹¹ have observed the rotifers to rise at night in two shallow ponds in Indonesia. Investigations on the factors that influence their diurnal migration in tropical waters should be an interesting field of study.

The author is indebted to Dr. M. Chandy under whose guidance the present work was carried out and to Prof. B. R. Seshachar for critically reading the manuscript and for providing facilities. For the grants-in-aid of the scheme on Fish Culture and for the award of a Junior Research Fellowship, the author's gratitude to the Council of Scientific and Industrial Research is recorded.

Department of Zoology,
University of Delhi,
May 27, 1961.

M. G. GEORGE.

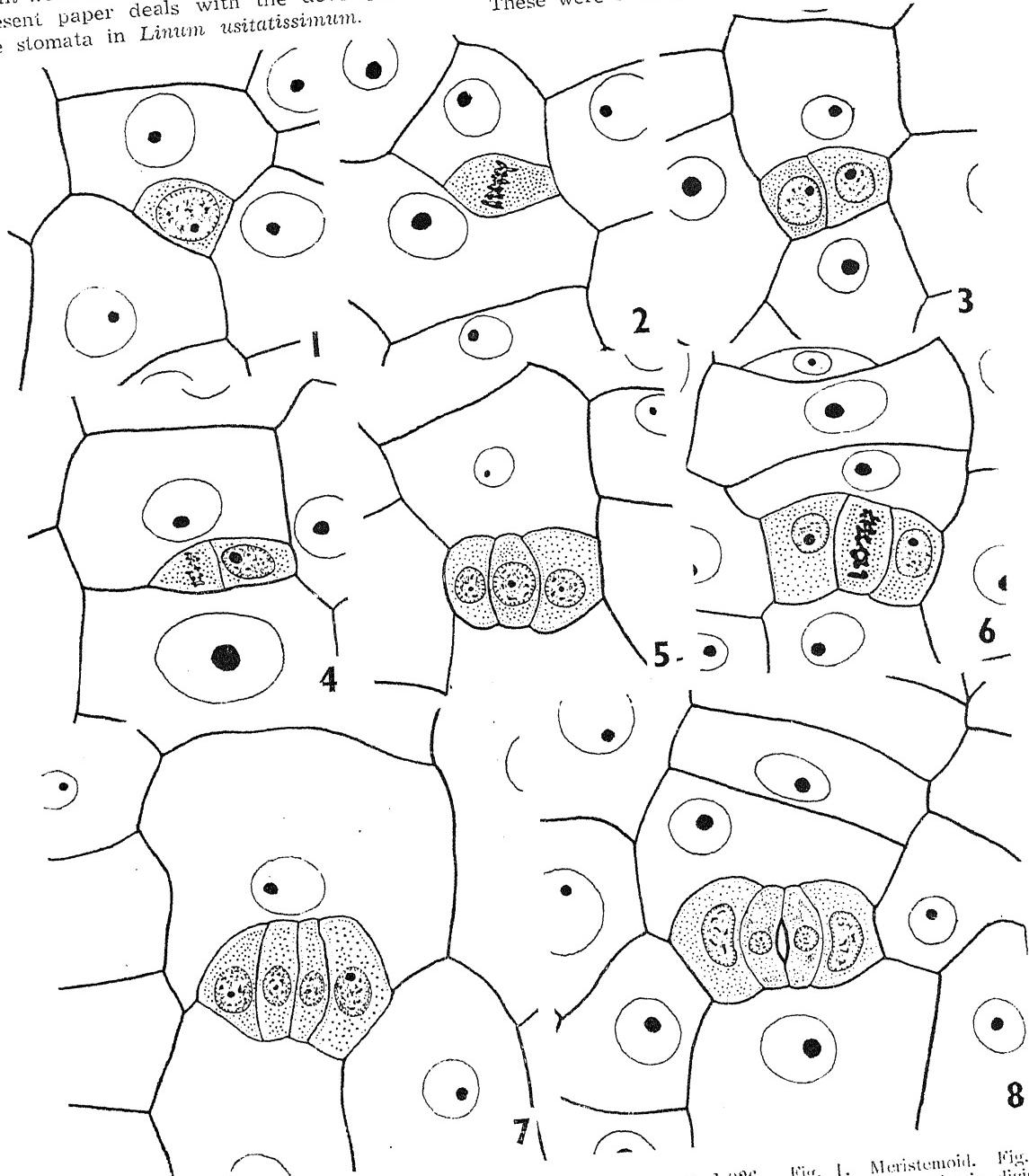
1. Anderson, H. H., *Journ. Asiatic Soc. Bengal*, Calcutta, 1889, **58**, 345.
2. Edmondson, W. T. and Hutchinson, G. E., *Mem. Conn. Acad. Arts and Sci.*, 1934, **10**, 153.
3. Alikunhi, K. II., Chaudhuri, H. and Ramachandran V., *Indian J. Fish.*, 1955, **2**, 257.
4. Das, S. M. and Srivastava, V. K., *Proc. nat. Acad. Sci. India*, 1956, **26 B**, 85.
5. Birge, E. A. and Judy, C., *Bull. Wisconsin Geol. Nat. Hist. Surv.*, 1922, **64**, 1.
6. Pennak, R. W., *Ecol. Monogr.*, 1949, **19**, 233.
7. —, *Univ. Colo. Stud. Biol.*, 1955, **2**, 1.
8. Wesenburg-Lund, C., *D. K. D. Vidensk. Selsk. Skr.*, *Naturv. og. math. Afsl.*, 9. R. II, 1930, **1**, I.
9. Pennak, R. W., *Limnol. and Oceanogr.*, 1957, **2**, 222.
10. George, M. G., *Hydrobiologia* (in press).
11. Vaas, K. F., and Sachlan, M., *Verh. int. Ver. Limnol.*, 1953, **12**, 309.

THE DEVELOPMENT OF STOMATA IN *LINUM USITATISSIMUM* L.

THE role of stomata in various physiological processes is well known. That they also have a systematic significance has been clearly brought out by several writers.^{5,6} Though developmental studies have been made on the stomata of many gymnosperms, the information on angiosperms is still rather scanty. The chief accounts are by Campbell,³ Porterfield,⁷ and Flint and Moreland,⁴ all dealing with the family Gramineæ. The stomata of the Crassulaceæ have been investigated by Strasburger,⁹ and Yarbrough.¹⁰ Recently Bondeson² described their development in *Trochodendron*, *Tetracentron* and *Drimys*. Artschwager¹ and Rao⁸

surveyed the stomatal types in the Gramineae and the Magnoliales but the stages of development were not taken into account by them. The present paper deals with the development of the stomata in *Linum usitatissimum*.

The leaves were collected from plants in the Botanical Garden of the Delhi University. Portions of epidermal peels at various stages of development were fixed in acetic-alcohol (1:3). These were stained with iron-acetocarmine and



Figs. 1-8. *Linum usitatissimum*. Development of stomata, $\times 1,026$. Fig. 1. Meristemoid. Fig. 2. Meristemoid undergoing first mitotic division. Fig. 3. Unequal cells formed after the first mitotic division. Fig. 4. One of the daughter cells of the meristemoid undergoing second mitotic division. Fig. 5. Advance stage showing two subsidiary cells and the median guard mother cell. Fig. 6. Guard mother cell in divisor stage. Figs. 7-8. Young and mature stomata.

later dehydrated through an acetic acid-butyl alcohol series and finally mounted in Canada balsam.

The epidermis of the lower surface of the leaf consists of uninucleate, richly cytoplasmic and hexagonal cells. The development of a stoma begins with the formation of a transverse septum on one side of an epidermal cell, producing two unequal cells (Fig. 1). The smaller cell can be distinguished from its mother cell and other epidermal cells by its lenticular shape, dense cytoplasm, and a prominent nucleus which occupies almost the entire cell cavity. This cell functions as the meristemoid or stomatal initial.

The meristemoid soon increases in size, especially in length; its nucleus divides and the chromosomes at the metaphase may be placed vertically (Fig. 2) or diagonally to the long axis of the initial. The daughter cells thus formed are again slightly unequal in size (Fig. 3). The smaller of the two has denser cytoplasm and a larger nucleus. In Fig. 4 this cell is seen in division resulting in the formation of two cells (Fig. 5). These, together with the undivided cell, constitute a row of three cells (Fig. 5). The median cell now acts as the guard mother cell. In the beginning it is smaller than the lateral cells but later enlarges and divides vertically (Fig. 6) forming two equal cells (Fig. 7) which gradually become bean-shaped and function as the guard cells. The two flanking cells constitute the subsidiary cells. These are distinguishable from the other epidermal cells by their lateral position, smaller size and oblong shape. The mature stomata (Fig. 8) are, therefore, of the Rubiaceous or paracytic type.⁶ Since the guard cells and the two subsidiary cells originate from the same meristemoid, the development conforms to the syndetocytic type.^{2,5}

I am indebted to Professor P. Maheshwari and Dr. R. N. Kapil for their keen interest and encouragement.

Department of Botany, G. S. PALIWAL
University of Delhi,
Delhi-6, May 1, 1961.

1. Artschwager, E., *J. Agric. Res.*, 1930, **41**, 853.
2. Bondeson, W., *Acta Hort. Berg.*, 1954, **16**, 169.
3. Campbell, D. H., *Amer. Nat.*, 1881, **15**, 761.
4. Flint, L. H. and Moreland, C. F., *Amer. J. Bot.*, 1946, **33**, 80.
5. Florin, R., *K. Svenska Vetensk Akad. Handl.*, 1931, **10**, 1.
6. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, 1950, **1 & 2**, Clarendon Press, Oxford.

7. Porterfield, W. M., *Bull. Torrey Bot. Cl.*, 1937, **64**, 421.
8. Rao, H. S., *Proc. Ind. Acad. Sci.*, 1939, **9 B**, 99.
9. Strasburger, E., *Jb. Wiss. Bot.*, 1866-67, **5**, 299.
10. Yarbrough, J. A., *Amer. J. Bot.*, 1934, **21**, 467.

GENETICS OF DWARF GROWTH IN COMMON WHEAT

In a previous communication the present authors reported about "grass clump" or "dwarf growth" formation in a cross involving the wheat varieties Gabo and R.S. 31-1.¹ Since no seed formation takes place when the crossed seeds are grown because of the premature death of the seedlings after the grass clump formation, the cross was again attempted by introducing a bridging variety. Wheat variety A. 115, a local selection from Madhya Pradesh, was used as bridging variety and was crossed with Gabo in 1957-58. The normal F_1 obtained from this cross was crossed with variety R.S. 31-1 in the years 1958-59. The F_1 of this three-way-cross was grown during 1959-60. The F_2 progeny of the normal F_1 plants has been planted during 1960-61. The data is summarised in Table I.

TABLE I
Reaction of the F_1 and F_2 of the three-way-cross (Gabo \times A. 115 \times R.S. 31-1) to dwarf growth

Material	No. of plants			X_2	P value
	Dwarf	Normal	Total		
F_1 observed ..	11	12	23	..	-
F_1 expected (1 : 1)	11.5	11.5	23	0.043	.95-.50
F_2 observed (raised from normal F_1 plants)	..	323	323	..	..

About the inheritance of dwarf growth in varieties of common wheat, McMillan² published an extensive article and on the basis of his theory most cases of dwarf growth can be explained. Assuming only one system of interacting factors, the occurrence of grass clumps can be explained on the basis of three main groups of factors, which are designated as *A*, *I* and *G*. Each group may consist of complementary and polymeric factors. The *G* group must be dominant for grass clumps to develop. If the *I* group is dominant (and the *A* group is not) it inhibits the expression of *G* and results in normal; but a dominant *A* group prevents the action of *I* in inhibiting *G*. One factor pair in each of the *I* and *G* groups is sufficient to account for the results; but in the group *A* two pairs of complementary factors, designated *Aa* and *Bb* are necessary. Both *A* and *B* must be

present in the dominant form to prevent *I* inhibiting *G*.

According to McMillan's theory Gabo has the genotype *AbIG* (Class I). R.S. 31-1 then may have the genotype *ABig* (Class II) or *abIG* (Class IV) and the bridging variety A. 115 of the three-way-cross may have *abIG* (Class III) or *abIg* (Class V). Dependent on the genotype of R.S. 31-1 and A. 115, there are four possibilities of their combination. The segregations thus obtained in this three-way-cross are enumerated in Table II.

TABLE II

Assignment of genotype under possible *F*, and *F*₂ segregations of the three-way-cross

Variety and genotype	<i>F</i> ₁ (three-way-cross)	<i>F</i> ₂ progeny of normal <i>F</i> ₁ plants
1 R.S.31-1— <i>AbIG</i> A.115 — <i>abIG</i>	All dwarf	..
2 R.S.31-1— <i>abIG</i> A.115 — <i>abIG</i>	1 dwarf : 1 normal	All segregating into 13 normal : 3 dwarf
3 R.S.31-1— <i>AbIG</i> A.115 — <i>abIg</i>	1 „ 1 „	Wholly normal <i>F</i> ₂ 's
4 R.S.31-1— <i>abIG</i> A.115 — <i>abIg</i>	1 „ „	1 × (13 normal : 3 dwarf) 2 × wholly normal

As observed in Table I, the *F*₁ of the three-way-cross has shown a close fit to 1 : 1 ratio and the *F*₂ progeny of the normal *F*₁ plants in the cross has shown no segregation and all plants have come out to be normal. According to McMillan's theory, where genotype of Gabo has already been designated as *AbIG* for dwarf growth, the genetic constitution for R.S. 31-1 can be suggested as *ABig* and that of A. 115 as *abIg* (Table II).

On the basis of the proposed genetic constitution of the varieties in the cross, the dwarf growth is mainly due to the dominant effect of Group G in the cross involving Gabo and R.S. 31-1, and its suppression in the cross Gabo × A. 115 is due to the presence of Group I in dominant form. In the cross Gabo × R.S. 31-1, Group I also being dominant could have prevented Group G in effecting the dwarf growth but since both A and B are present in the dominant form, it has prevented *I* inhibiting G.

Authors are grateful to Dr. M. S. Swaminathan, Cytogeneticist, I.A.R.I., New Delhi, and Dr. J. G. Th. Hermsen, Institute of Agricultural Plant Breeding, Wageningen, Netherlands, for their valuable suggestions in the preparation of this note.

Agric. Research Station,
Durgapura, Jaipur,

S. M. GANDHI.

M. P. BHATNAGAR.
Rajasthan, February 23, 1960.

1. Bhatnagar, M. P., Bhargava, P. D. and Gandhi, S. M., *Curr. Sci.*, 1960, **29**, 68.
2. McMillan, J. R. A., *C.S.I.R. Bulletin* No. 104, Melbourne (Australia), 1937.
3. Morrison, J. W., *Euphytica*, 1957, **6**, 213.

RESISTANCE OF PADDY VARIETIES TO BLAST IN UTTAR PRADESH

BLAST (*Piricularia oryzae* Cavara) is the most serious disease of paddy and although it is confined at present to a few pockets in some acres, it may eventually spread to new areas and cause more damage. With a view to evolve high yielding paddy varieties, resistant to blast, a programme of testing selected varieties in co-operation with the Assistant Economic Botanist (Paddy) was initiated in 1958 at Kanpur and the present paper gives a summary of the data collected on twenty-nine paddy varieties and cultures during the last three seasons.

Since the severity of blast is correlated directly with excessive nitrogenous manuring, the trials were undertaken at the Usar Reclamation Farm at Chakeri near Kanpur where due to the supply of sewage water for irrigation and heavy application of nitrogenous manure, moderate to heavy infection of blast has been observed every year. The selected varieties were grown in randomised blocks with four replications. Regular observations of infection rating of *Piricularia oryzae* were taken from the milk stage until the maturity of the crop because the disease appeared only at this time at Chakeri. Neck-rot infection was not common, hence detailed observations were taken according to Padmanabhan and Ganguly's¹ technique on the type and intensity of spotting on fifty leaves selected at random from every variety. According to this technique the type of spots and the number of each type of spots are scored for a set of infected leaves and the final infection rating is given by multiplying the two numerical values and finally classifying the product to indicate the resistance, moderate resistance, moderate susceptibility, and susceptibility of a particular variety to blast. According to these categories of resistance, used in the tests reported here, the twenty-nine paddy varieties and cultures are classified as follows :—

Resistant : Nil.

Moderately resistant : S.M. 8, T. 100, N. 12, T. 22-A, T. 36, H. 755, B.J. 1, T. 3 and C.P. 9.

Moderately susceptible : T. 1, C.H. 55, P.T.B. 10, C.H. 10, C.P. 6, T. 6522, C.H. 13, N.S. 41, T. 21, N.S.J. 163, T. 136, N.S. 42 and C.O. 13.

Susceptible : N.S. 135, N.S.J. 98, C.H. 4, N.S.J. 161, N.S.J. 157 T. 137 and N.S. 134.

Thanks are due to the Director, Central Rice Research Institute, Cuttack and the Assistant Economic Botanist (Paddy), Nagina, U.P., for the supply of paddy varieties and cultures and to the Agricultural Chemist to Government, Uttar Pradesh, Kanpur, for providing facilities for the conduct of these trials at the Usar Reclamation Farm, Chakeri.

R. S. MATHUR.

M. P. MISRA.

Laboratory of the Plant Pathologist
to Government, Uttar Pradesh,
Kanpur, March 14, 1961.

- Padmanabhan, S. V. and Ganguly, D., "Breeding rice varieties resistant to blast disease caused by *Piricularia oryzae* Cav. I. Selection of resistant varieties from genetic stock," *Proc. Ind. Acad. Sci.*, 1959, **50** (5) B, 289.

DISTRIBUTION OF *CUCUMIS* VIRUS 2C IN MOSAIC-INFECTED BOTTLEGOURD (*LAGENARIA SICERARIA* STANDL.) PLANTS

It is often noticed that various organs of a virus-infected plant do not always possess the casual virus in them even in spite of the systemic nature of the infection. *Cucumis* virus 2C infects bottlegourd plants systemically causing a mosaic disease.¹ Generally the leaves of infected plants alone show apparent symptoms of disease producing a light and dark-green mottle with occasional vein banding and puckering. The present investigations were undertaken to ascertain whether all the organs of an infected host plant actually possess the virus in them.

Various organs of a mosaic-infected bottlegourd plant and the parts composing each organ were separately tested for the presence of the virus. Extracts from each of the plant part were made by macerating the tissue in distilled water in the proportion of one ml. to each gram of plant tissue. Healthy bottlegourd plants were inoculated by gently smearing the leaves in presence of carborundum powder. Control plants were inoculated with extracts from corresponding parts from a healthy bottlegourd plant.

Results of infectivity tests are shown in Table I.

TABLE I
The presence or absence of mosaic virus in various organs of virus-infected bottlegourd plant

Plant parts	No. of inoculated	No. of infected	Presence (+) or Absence (-) of virus
Root	..	5	5 +
Root hair	..	5	4 +
Stem	..	5	5 +
Tendril	..	5	5 +
Leaf	..	5	5 +
Petiole	..	5	5 +
I. amina	..	5	5 +
Flower	..	5	5 +
Calyx	..	5	5 +
Corolla	..	5	5 +
Stamens	..	5	5 +
Pollen	..	5	5 +
Pistil	..	5	4 +
Fruit	..	5	5 +
Epicarp	..	5	5 +
Mesocarp	..	5	5 +
Endocarp membrane	..	5	5 +
Seed	..	5	5 +
Testa	..	5	5 +
Tegmen	..	5	5 +
Embryo	..	5	5 +
Cotyledons	..	5	5 +
Axis (Radicle & plumule)	5	0	1 +

The bottlegourd mosaic is not seed-borne.¹ The presence of active virus both in the pollen as well as in the embryo, therefore, is of special interest because viruses that are not seed-borne generally are neither known to enter the pollen nor the embryo.² The absence of seed transmission in some viruses may be due to their inability to infect and survive in the young gametophytic and meristematic tissues.³ How long does the mosaic virus survive in the embryo and in other parts of the bottlegourd seed, therefore, needs to be determined. Investigations in this direction are in progress.

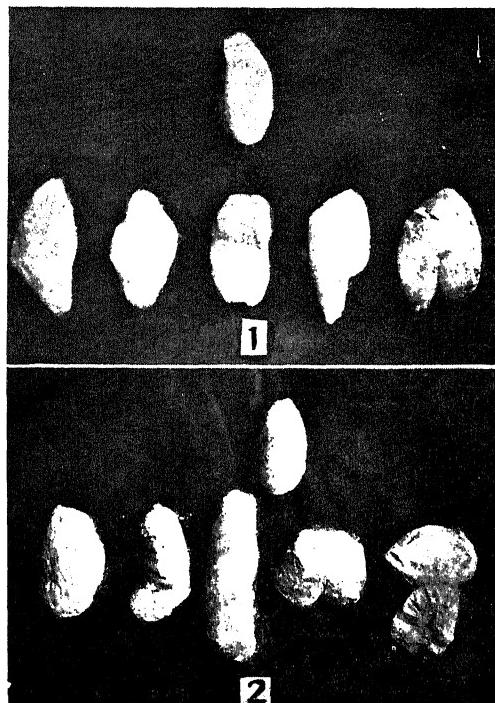
Botany Department, S. B. LAL.
Govt. Agricultural College, L. S. CHAUHAN.
Kanpur, February 25, 1961.

- Vasudeva, R. S., Raychaudhuri, S. P. and Singh, J. N., *Indian Phytopath.*, 1949, 2, 180.
- Bawden, F. C., *Plant Viruses and Virus Diseases*, Chronica Botanica Co., Waltham, Mass., 1956, 3rd Edition.
- Crowley, N. C., *Virology*, 1959, 8, 116.

OCCURRENCE OF DOUBLE-COCOON FORMING PHENOMENON ON *PHILOSAMIA RICINI* HUTT. AND *ANTHERAEA ASSAMA* WESTW.

DOUBLE-COCOON formation is reported¹ to be the peculiar phenomenon to *Bombyx mori* Linn.

Observations made in the cocoon crops of *Philosamia ricini* Hutt. and *Antheraea assama* Westw., however, revealed the presence of the similar type of cocoons and numbers collected of such type of cocoons were 9 and 5 out of a total of 8136 and 7318 cocoons respectively. Eight of these abnormal cocoons of *P. ricini* were formed by two larvæ and one by three. On examination, the sex of the associated larvæ



FIGS. 1-2. Fig. 1. Some double cocoons (lower row) of *P. ricini* with a normal one (upper row). Fig. 2. Some double cocoons (lower row) of *A. assama* with a normal one (upper row).

of these nine cocoons was found to be female. In *A. assama*, all the cocoons contained only two larvæ. Sexes were both female in seven cases, both male in one case and one male and one female in four cases. In two cases, sex of one of the larvae was female and in one case, it was male. Sex of their partners could not be identified. It was noted that the double cocoons of *P. ricini* were collected both from overcrowded and thinly populated cocoonage. Attempt made by an experiment to force the

larvæ of *P. ricini* and *A. assama* to form double cocoon by providing them inadequate space was without success.

Regional Sericultural Research, J. N. TALUKDAR.
Station, Titabar, Assam, March 25, 1961.

1. Carboni, P., *Silk* (English Edition), Chapman & Hall Ltd., London, 1952, p. 17.

ON THE FLORAL MORPHOLOGY OF *CURCUMA LONGA* L.

In a recent communication² in this Journal concerning the "flowering behaviour and anthesis of *Curcuma longa* L.", the authors refer to "two sterile stamens attached at the base of the pistil". This is also indicated by their Figs. 1 and 2. On an examination of material of the same species in the possession of the present writer, these are found to be actually the two epigynous nectaries. It may be observed that the epigynous nectaries are of almost universal occurrence in the family. That the glands are modified stamens is an age-old conception³ which, although corroborated by some later investigators,⁴ is to be regarded as merely of historical interest in the light of modern researches. On the basis of anatomical evidence,⁵⁻⁷ it has been shown that these are special vascularized emergences of carpillary tissue and are not in any way connected with the androecium. It may be pointed out that these are the last organs to appear in the zingiberaceous flower which has been the opinion of even an earlier writer,³ and are, perhaps, organs of later origin as well. In form, structure, development and vasculature, these organs suggest no connection with the androecium and are best interpreted as nectariferous appendages of the ovary, anatomical evidence for which, amidst others, is conclusive.

Studies in the vascular anatomy of the flower of a number of species of this family are in progress and the results will be published elsewhere.

Dept. of Botany,
The Institute of Science,
Bombay, May 10, 1961.

R. M. PAI.

- *1. Brown, R., *Remarks on Apostasia in Wall. Plant Asiat. Rar.*, 1830, 1, 75.
2. Patnaik, S., et al., *Curr. Sci.*, 1960, 29, 402.
*3. Payer, J. B., *Traité d'Organogénie comparée de la fleur*, Paris, 1857, 674.
4. Raghavan, T. S. and Venkatasubban, K. R., *Proc. Ind. Acad. Sci.*, 1941, 13B, 325.
5. Rao, V. S., et al., *J. Indian Bot. Soc.*, 1954, 33, 118.
6. — and Pai, R. M., *J. Univ. Bombay*, 1959, 28, Part 3, 82.
7. — and —, *Ibid.*, 1960, 28, Part 5, 1.
* Not consulted in the original.

REVIEWS

Organic Electronic Spectral Data—Vol. I (1946-52). Edited by M. J. Kamlet; Vol. II (1953-55). Edited by H. E. Ugnade. (Interscience Publishers Inc., 250, Fifth Avenue, New York-1), 1960. Pp. xiv + 1208. Price: Vol. I, Subn. Copy \$ 25.00. Single \$ 28.50; Pp. x + 919; Vol. II, Subn. Copy \$ 15.00. Single \$ 17.50.

Among the various physical methods of organic analysis the spectroscopic methods have taken a predominant place firstly because of the wealth of information that can be obtained from them and secondly because of the comparatively easy techniques involved, especially with the recent developments in the instrumentation employed in their study. The three recognized methods in this field are the ultra-violet absorption spectroscopy, the infra-red spectroscopy and the Raman effect spectroscopy. These three methods give almost complete information about the molecule regarding structure, functional groups, bondage, molecular forces, distances and angles.

With the advent of photoelectric spectrophotometry the study of the electronic spectra of molecules has reached a high degree of perfection and standardization. With the precise data thus available and with the specificity in the relation between structure and the maximum wavelength absorption in the ultra-violet, it is now possible to go a long way in the empirical interpretation of organic molecular structure.

Whereas comprehensive catalogues of organic data on Raman and infra-red spectra are presently to be had, there has appeared, as yet, no such compendium of ready reference for ultra-violet absorption data. The projected series of volumes whose publication has been undertaken by the Interscience Publishers will supply this need. The hugeness of the task involved in this undertaking can easily be realized from the size of the first two volumes that have come for review.

Essentially the data given are λ_{max} and $\log \epsilon$ for organic molecules. Volume I of 1,208 pages, covers the data abstracted from journals published during the years 1946-52 and Volume II of 919 pages, those for the years 1953-55. Each page contains four columns. The first column gives the compound and the molecular formula. The arrangement of compounds corresponds in most respects with that followed in the Chemical

Abstracts Formula Index. The second column contains the solvent or phase in which the spectrum was studied. The numerical data in the third column represent wavelength (λ_{max}) values in $m\mu$ for all maxima, shoulders and inflections. The logarithm of the corresponding molar absorptivity ($\log \epsilon$) is given in parenthesis. The last column gives the reference in code numbers explained at the beginning in the text.

It should be noted that data are included even if known with absolute certainty to be incorrect, as such information may often be quite valuable by demonstrating the operation of otherwise unknown chemical or photochemical transformations.

Abstraction of data has been done from 65 journals. The bulk of the data has been abstracted from *Journal Chem. Soc.*, *Jour. Am. Chem. Soc.* and *Helv. Chim. Acta*. The two Indian Journals included in the list are the *Proc. Ind. Acad. Sci.* and *J. Ind. Chem. Soc.* Vol. III will cover data for 1956-57. Vol. IV for 1958-59 and Vol. V for 1960-61. These volumes are indispensable for organic research libraries.

A. S. G.

Introduction to Statistical Thermodynamics.
By T. L. Hill. (Addison-Wesley, Pub. Co., Inc., Reading, Massachusetts, U.S.), 1960. Pp. xiv + 508. Price \$ 9.75.

The author of this book is well known for his earlier work *Statistical Mechanics* which was published a few years ago. The present volume is intended primarily as a text-book for courses in physics or chemistry, and provides a quite extensive coverage of topics of current interest in equilibrium statistical mechanics.

The book is divided into four parts. Part I (Chapters 1 and 2) is concerned with the principles or postulates of statistical mechanics, Part II (Chapters 3-13) contains applications of the principles developed in the previous part to systems of independent molecules (e.g., an ideal gas) or of other independent subsystems. The more complicated but also more interesting problems which arise when molecules can no longer be treated as independent of each other (because of intermolecular forces) provide the subject-matter of Part III (Chapter 14-21). While most of the applications in Parts II and III have to do with classical (high-temperature)

limit of quantum statistics, Part IV (Chapter 22) is concerned with problems for which the classical limit is not valid (e.g., helium gas at low temperatures). In this chapter, topics such as Bose-Einstein and Fermi-Dirac statistics, helium at low temperatures, inter-molecular interactions, are treated in detail.

The book will provide a valuable text for students of physics and chemistry.

K. S. V.

Progress in Endocrinology : Proceedings of a Symposium held at Edinburgh, August 1959.
Part I—*Neuroendocrinology and Endocrinology of the Thyroid and Parathyroid Glands*, 1960. Pp. 166. Price 45 sh.

Part II—*Biochemistry and Biological Actions of Steroids and other Hormones*, 1961. Pp. 167. Price 45 sh.

Edited by K. Fotherby, J. A. Loraine, J. A. Strong and P. Eckstein. (Cambridge University Press, London, N.W. 1).

The two volumes which form No. 9 and No. 10 in the series *Memoirs of the Society for Endocrinology* record the proceedings of a conference held in August 1959 to survey the current knowledge on the topics mentioned in the title.

In the First Part twenty-three papers with subsequent discussions by anatomists, physiologists, biochemists and endocrinologists, together with extensive bibliographies are reproduced in full. The names of the contributors make a formidable list of internationally known experts. Each paper summarizes the knowledge in the particular field and indicates the results of the researches of experts who participated in the Conference. Most of the information has not been previously published and many new and fascinating perspectives are opened up by ideas developed during the course of the discussion.

The Second Part contains 45 assorted papers on (i) Steroid Biochemistry; (ii) Biological Actions and Interrelationships of Steroids and other Hormones and (iii) Endocrine Glands and their Relationship to Cancer.

In the opening paper, 'Some recent advances in oestrogen biochemistry', Prof. G. F. Marrian has reviewed the recent work on the isolation of eight new oestrogen metabolites. A spirit of enthusiasm is found to permeate through this paper and the pathos in the "swan song" is subdued. A novel, enzymic method for the determination of plasma corticoids, which has been suggested in a paper appears to be of practical value. The finding, in another paper, that there is an alternation in the normal secre-

tion pattern of an adrenal cortex in hirsute women undergoing ACTH administration, is of clinical interest.

Most of the papers from Section (ii) are experimental in nature and preliminary in character. The introductory note to Section (iii) by Prof. C. Dodds and the paper on "The Endocrine System and Cellular Autonomy" by Prof. A. Haddow are informative and thought-provoking. In one of the papers, dealing with endocrinological aspects of mammary cancer, Prof. O. Mühlbock has shown that susceptibility of the target organ may be playing a decisive role in the production of cancer. Although, the nature of susceptibility is yet unknown, it is the core of the cancer problem and the ultimate objective of much of the present-day research. Judged from this aspect the paper is very important.

The two memoirs afford the reader a bird's-eye-view of the progress of the varied types of endocrinological studies at present in progress in several laboratories. It is of special value to those who are actively engaged in endocrinological research.

V. R. KHANOLKAR.

Preparative Methods of Polymer Chemistry.
By Wayne Sorenson and Tod W. Campbell. (Interscience Publishers, Inc., New York), 1961. Pp. viii + 337. Price \$ 10.50.

The available books on polymers deal with the kinetics and mechanism of polymerization and with technology. This book is unique and fulfils a very real need, describing detailed procedures for the laboratory synthesis of a large number of polymers. It is a most valuable addition to the library of polymer chemists and technologists as well as synthetic organic chemists. Methods described in journals and patents have been collected and supplemented by the practical experience of the authors and their colleagues in the Du Pont Co. A brief introduction is followed by six chapters with the following titles : preparation, fabrication and characterization of polymers ; polycondensation and hydrogen transfer polymerization ; addition polymers from unsaturated monomers ; ring opening polymerization ; nonclassical routes to polymers ; and synthetic resins. A typical preparation is poly(hexamethylene sebacamide) (6-10 nylon), known sometimes as the nylon rope trick ; the procedure is described in such detail that no difficulty should be encountered in duplicating it. However the book does not merely consist of preparative details, and experimental methods are preceded by an adequate discussion of the

principle involved. The chapter on addition polymerization gives a very clear account of stereospecific polymerization including the preparation of catalysts. The chapter on non-classical routes to polymers deals with cyclopolymerization, polymerization of carbonyl compounds, mono-isocyanates and diazo-compounds; preparation of poly(*p*-xylene, polymerization of norbornylene, 1-*n*-polyamides, and polyphenylene ethers. The chapter on synthetic resins is relatively short and limited in scope. The sketchy appendix on sources of equipment and chemicals does not fulfil a useful purpose; on the other hand, the three indices on initiator systems, reaction systems, and polymerization through functional groups, which precede the general index, are a valuable guide to the basis on which polymers are designed.

K. V.

- Butterworths Publications in Chemistry.** By C. W. Wood and A. K. Holliday, 1960.
Inorganic Chemistry. (An Intermediate Text). Pp. viii + 393. Price 21 sh.
Physical Chemistry. (An Intermediate Text). Pp. viii + 392. Price 21 sh.
Organic Chemistry. (An Introductory Text). Pp. xxii + 321. Price 21 sh.

These three books, written by an experienced senior Science Master of a school and a senior University Lecturer in inorganic and physical chemistry, cover the chemistry of the standard required for "the C.E.C. advanced and scholarship level examinations of the various examining bodies" and for "the first year courses leading either to a degree in Chemistry or to a degree in some other science subject" in Britain. In each of them, due importance is given to the historical approach to new discoveries and new theories so as to arouse the curiosity and interest of the student in the newer developments in the three main branches of chemistry. Certain topics such as atomic structure, classification of elements and valency figure both in the inorganic and physical chemistry books, valency appearing also in the organic book, but with variation in detail and emphasis in keeping with the subject of the book.

The inorganic book deals with elements and their important compounds from the viewpoint of the periodic classification, attempt being made to explain their physical and chemical properties in terms of such fundamental factors as electronic structure, type of bond, bond length, ionic radius, dipole moment, paramagnetism and so on. In view of recent developments, boron, fluorine and titanium and their compounds are

described in greater detail than would be expected in a book of intermediate standard. Complex, clathrate and 'sandwich' compounds are also included to give an idea of the wide variety of inorganic compounds. The last chapter on lanthanides and actinides brings out the significance of transitional and transuranium elements.

Atomic structure and valency are treated in greater detail in the physical chemistry text than in the previous one, with inclusion of the structure of the nucleus, nuclear fission, formation of transuranium elements and atomic orbitals. Particularly well-written are the chapters on solids, chemical equilibria and kinetics (the difference between the two being indicated very clearly), the ionic theory (modern concepts of acid and base being included), catalysis (with numerous examples of theoretical and practical value), oxidation and reduction, and colloids. Model problems are worked out in some cases.

Organic compounds are classified and studied according to their reactive, functional groups. One of the later chapters on structure and reactivity discusses the relation between reactivity and type of chemical bond, introducing with appropriate illustrations the concepts of resonance and delocalized orbitals. Methods of separation and purification including even chromatography, determination of constitutional formulae utilising infra-red, X-ray and nuclear magnetic resonance data, and isomerism in its various forms are described in the last chapters to enable the student to appreciate these better after a fair knowledge of organic compounds.

All the three books, written in a clear, simple language, can very well serve as an excellent introduction to the new three-year degree course in Chemistry.

L. M. YEDDANAPALLI

- Metabolic Pathways**, Vol. I. Edited by D. M. Greenberg. (Academic Press, New York, London), 1960. Pp. xv + 572. Price \$18.00.

The volume under review is the second edition of *Chemical Pathways of Metabolism* and in editing the same, Dr. Greenberg has taken note of the rapid progress made in recent years on the specific enzyme functions for biotin and for Vitamin B₁₂ and of the metabolism of the carotenoids, vitamins and enzymes. Twelve topics dealing with various chemical aspects of metabolism have been written by scientists who are actively working in the respective fields. The subjects covered are free energy and entropy in metabolism, mitochondrial system of enzymes, glycolysis, the tricarboxylic acid cycle, other

pathways of carbohydrate metabolism, bio-synthesis of complex saccharides, fatty acid oxidation and synthesis, ascorbic acid, metabolism of phosphatides, metabolism of sterols, metabolism of steroid hormones as well as carotenoids and Vitamin A. Entropy changes are of great interest to biochemists, as they give an idea of the structural changes of the products relative to the reactants. The cells of all aerobic organism contain specialised structures such as mitochondria which have enzyme systems necessary for basic cellular functions. Various aspects of carbohydrate, fat, vitamin and sterol metabolism are also considered in the light of recent research work on these subjects. In short, the present volume can be considered a veritable mine of information and the contributors are to be congratulated for presenting comprehensive reviews in such a lucid and graphic manner. The printing and general get-up of the volume are excellent and are in keeping with the highest traditions of Academic Press.

P. S. SARMA.

Introduction to Biochemistry. By E. O. F. Walsh.
(The English University Press, 102, Newgate Street, London, E.C. 1), 1961. Pp. viii + 454.
Price 27 sh. 6 d.

This will be an ideal introductory text-book on biochemistry for students of biology and medicine who having already acquired a basic knowledge of chemistry would like to extend their interest of study to the exciting field of the chemistry of life.

The subject-matter has been judiciously chosen and logically arranged. The language is that of an experienced teacher, simple and lucid. The book will not only provide the students with a fundamental understanding of the subject but also stimulate interest in them for further reading.

After the first few chapters dealing with the composition of living matter, enzymes, and the chemistry of digestion, the author describes in detail the role of phosphorus in the chemistry of life, metabolism of carbohydrates, cellular respiration and photosynthesis. These are followed by chapters on the metabolism of lipids and that of nitrogen. Separate chapters deal with blood, vitamins, and hormones.

The book can be recommended not only to graduate students of biochemistry but also to more advanced readers of the subject who will find in it a wealth of information and also in places the author's own views on important unsolved problems in this field of study.

A. S. G.

Plant Physiology—A Treatise—Cellular Organization and Respiration. Edited by F. C. Steward. (Academic Press, New York; India: Asia Publishing House, Bombay-1), Vol. I A, 1961. Pp. xxiv + 331. Price \$ 13.

We have before us the first volume, or shall I say, sub-volume of the much awaited treatise in *Plant Physiology*—a worthy inauguration volume of a series yet to be printed. The subject-matter of this volume is Cellular Organization and Respiration—both very fundamental aspects of plant physiology. In the successor volumes we are promised the other aspects: Vol. I B, Photosynthesis and Chemosynthesis; Vol. II, Plants in relation to Water and Solutes; Vol. III, Inorganic Nutrition of Plants; Vol. IV, Organic Nutrition and Metabolism; Vol. V, Analysis of Growth and Vol. VI, The Physiology of Development.

Prof. Steward's introduction to the Treatise entitled: *Plant Physiology*—The changing scene, is as educative as it could be, presenting as it were, a whole panorama of events, where the impact of physical sciences has made plant physiology the precise subject that it is today. The great achievements of Nicholas Théodore de Saussure, the author of *Recherches chimiques sur la vegetation*. Robert Brown, Schleiden and Schwann, Nageli and Hofmeister, Boussingault, Lawes and Gilbert, Sachs, Knop, Pfeffer and other 'dramatis personæ' of a whole century of dynamism in this field of science have been flashed before us making it a most eloquent reading. Prof. Stewart aptly quotes Erwin Schrödinger from his book *What is Life*—"it is by avoiding the rapid decay into the inert state of 'equilibrium', that an organism appears so enigmatic" and again "nature feeds on negative entropy" and goes on to say that negative entropy is inherent in the creation of the orderly patterns and restricted molecular movements which biological structure and organization present.

Coming to the subject-matter of the Volume under review: Chapter I is on the Plant Cell and its Inclusions by R. Brown; Chapter II on Proteins, Enzymes and the Mechanism of Enzyme Action by Birgit Vennesland and Chapter III on Cellular Respiration by David R. Goddard and Walter D. Bonner. There is a conventional author and subject index sandwiching an index to plant names at the end of the volume. All three chapters are very ably written, well illustrated and terminate in an exhaustive bibliography on the subject. I have immensely benefited by reading them.

The get-up of the book is very good although quite a few printing errors have crept in but it does not in any way distract the reader as they are scarce. The subjects chosen for this volume blend well and I warmly commend them to every student of plant physiology, whether at the Masters' level or engaged in research for reading and absorption. I should, however, add that it is an advanced treatise and is definitely for serious reading by those with a background of modern physiology.

T. S. SADASIVAN.

Advances in Agronomy, Vol. 12. Edited by A. G. Norman. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xi + 464. Price \$ 12.50.

This volume, in the series, contains eight review articles on diverse subjects. The researches conducted in the past decade on the fundamental properties of 2-layer, 3-layer, amorphous and other clays relating to cation exchange, anion sorption and sorption of organic compounds and the recent refinements in the techniques of their identification and quantitative estimation have been summarised by Rich and Thomas. In the next article Garisson, Bohart, App, Hardison and Justice have cooperated to review the progress of technical advances in seed production, testing and quality in forge seed. Nursery fertilization is as important as the fertilizer application to forest trees. Stoeckler has reviewed scientific investigations conducted on the former and Arneman on the latter subject. This is the first real assessment in this field. In line with previous regional articles the agronomy of South-west U.S.A. has been described by Fuller, McAlister and Metcalfe. Due to technological improvements South-West agriculture still continues to produce a surplus of food-fibre and live-stock in spite of substantial progressive reduction in acreage in the past two decades and increase in population. Soyabean production suffers from inconsistent response from direct fertilization and the exact knowledge of the critical periods in the life-cycle of the crop which limit productivity. Therefore, Ohlrogge has reviewed the mineral nutrition of the crop and Howell its physiology to elucidate these facts. Parr and Bertrand have reviewed literature on the factors controlling infiltration rate in the soil; the recent advances in techniques for the determination of infiltration rate and the theoretical studies on the subject. Recent information on taxonomy, general morphology, physiology and ecology, diseases and pests, weed control, breed-

ing and genetics; cultural and manorial practices has been summarised by Fergus and Hollowell. The report on genetics and inheritance; adaptation of varieties and seed production techniques indicates substantial progress.

These reviews bring the subjects treated up-to-date. However, it should be mentioned that only few reports on foreign researches other than those in the U.S.A. have been included, particularly on red clover and technological advances in seed production and testing.

P. C. RAHEJA.

The Metabolism of Oral Tissues. (*Annals of the New York Academy of Sciences*, Vol. 85, Art. 1), 1960. Pp. 1-449. Price \$ 4.50.

In spite of the rapid advances in the art and science of dentistry, the intermediary biochemical and metabolic processes responsible for the oral tissue changes in diseases of nutrition and metabolism are still largely unknown.

This monograph attempts to review, current knowledge of the mouth, over and beyond the dental apparatus and to cover the entire problem of the development, structure, environment, and metabolism of the tissues in the oral cavity.

The monograph examines all of the principal tissues that are critically involved in oral pathology, including specifically the hard tissues of the teeth—the enamel and the dentin—which are involved in teeth decay; the alveolar bone and other supporting tissues of the teeth involved in periodontal disease and malocclusion; the oral mucous membrane that may well prove to mirror, nutritional, hormonal and other metabolic disturbances and a variety of atrophic, hypertrophic and neoplastic pathology; and finally, the salivary gland structure and function related to the maintenance of health, both in the hard and soft tissues of the mouth.

The evolutionary aspects of the enamel, dentine, bone and cartilage; genetics of the oral structures; congenital malformations of the face and mouth as teratogenic effects of hypervitaminosis AD and the delicate interplay of local and systemic etiological factors in the causation of certain oral diseases, constitute the chapter on "Perspectives on oral tissue metabolism".

The discussions on cariostatic effect of phosphate and its mode of action, electron microscopic studies on the structure of the teeth, crystallographic studies of calcium carbonate phosphate and the relationship of host metabolism to dental caries present many new concepts on the physiology and structure of the teeth.

The hormonal control over the rhinomaxillary salivary gland; aerobic oxidative metabolism and the proteolytic and amylase enzymatic activities of these glands; the important role of salivary glands in iodine metabolism and indirectly on thyroid functions; and finally the isolation of "Parotin", a salivary hormone have emphasized that the salivary glands are part and parcel of the endocrine system.

Biochemical, histochemical and electron microscopic studies relating to the tongue, oral mucosa, and the periodontal tissues, present highly informative data on keratinization, leukoplakia, nutritional interrelationship to the pathological changes in the tongue and many clinical disorders associated with periodontal tissues.

M. Srida

Bradley Volume. (*American Journal of Science*, Sterling Tower, New Haven, Conn.), 1961. Pp. vii + 433. Price \$3.50.

This volume has been published by the *American Journal of Science* to honour Prof. W. B. Bradley on his 61st birthday for the distinguished services rendered by him in the cause of Geology. Several well-known Geologists have contributed articles to this volume and have made it a very useful number.

In the first article, Prof. W. P. Woodring has given an excellent summary of the life and work of Prof. Bradley. There are thirty-seven other articles covering a very wide range of subjects in Geology, like igneous, sedimentary and metamorphic petrology, Mineralogy, Palaeontology, Palaeobotany, Stratigraphy, Geomorphology and Structural geology. Although many of the articles deal with American geology, the conclusions arrived at are of wider geological interest. A few of the articles like 'The nature of residual liquids from crystallization with data on the system mepheline-anorthite-silica' by F. M. Schairer and H. S. Yoder and 'Notes on the measurements of faunal resemblance' by G. S. Simpson and 'A new method of plotting chemical analyses of basaltic rocks' by K. G. Murata are of a specialized type undertaken as original investigation and are of interest to all geologists.

In collecting and publishing such a large number of articles, the *American Journal of Science* has paid a tribute to Prof. Bradley in his sixty-first birthday and has also provided the geologists all the world over with plenty of useful geological information.

M. R. S.

Cytogenetics and Plant Breeding. By N. Krishnamoorthy and S. N. Chatterjee Chakrabarti, C. P. Varadarajulu and C. V. Madras (Eds). 1962. Pp. xv + 633. Price Rs. 20.

The book is the revised and enlarged edition of the book by S. N. Chatterjee Chakrabarti and S. V. Parthasarathy first published in 1943 and reprinted with small addition in 1953. The book when first published met a long felt need for a tex book on genetics with data obtained in tropical crop with which the students could be expected to be familiar. This second edition which is an improvement on the first contains many new features. In addition to some rearrangement of the subject matter, new chapters on Allelism, Sex inheritance in plants, Cytoplasmic inheritance and heterosis have been introduced. The lists of linkage values, gene symbols and chromosome numbers have been made more comprehensive and brought up to date. It has however to be mentioned that they are not final. The gene symbolization in rice is still continuing and is better revised for acceptance on an international basis.

As mentioned by Dr. Pal in his foreword, recognition of the genes by which transmission takes place has so altered the ideas and experimental methods employed in animal and plant breeding and in medicine that genetics can now be regarded as the axis in the conceptional structure of biology. New experimental techniques have become available to the investigator, and intensive work is in progress. It may be remarked that the book does not do full justice to such recent work. The book is published in 1960 and contains over 700 references in bibliography but hardly a hundred of them refer to publications subsequent to 1960 except in cases where the senior author was himself interested in.

On page 334 the reference must be to *Oryza officinalis* and not to *Oryza latifolia*. Similarly, *O. perennis* might have been used instead of the old *O. longistaminata*. Brief additional information on biochemical concept of gene, nature of action of new mutagenic photoperiodism, embryoculture, concept of geographical races in relation to practical breeding, use of discriminant function, modification in pedigree breeding, etc., could have made the book more useful for post-graduate student.

The authors of the book have been associated with teaching of genetics and cytology for several years in the Agricultural College, Coimbatore, and the senior author has built up an active section on cytogenetics at the post-graduate level in the same institute, and they may be

congratulated on the successful work they have accomplished in publishing this text-book. The book is sure to be welcomed even outside India, in countries of the near and far east where teaching of genetics in the local Agricultural Colleges is receiving greater attention.

K. R.

Introduction to Physical Chemistry, Vol. III. By S. N. Mukherjee (Art Union, 56/7, Grey Street, Calcutta-6), 1960. Pp. xi + 332. Price Rs. 25.

The book is intended to be an introductory text-book on Physical Chemistry for post-graduate students of Indian Universities. It is an extension of the author's first two volumes prepared for undergraduate courses, and the continuity of the numbering of the chapters (XLII-LII) has been maintained. In writing the book the author seems to have had the conventional post-graduate syllabus of an Indian University before him. The author has taken considerable pains to collect his materials from different well-known text-books and present them in a manner which is sure to appeal to average students who have in view the passing of a University examination. Teachers also new to the profession, will find "ready-made" material for their class-room lectures. However, to gain clear and fundamental knowledge on the subject the students should supplement their reading by referring to the more standard books on the various topics dealt with here.

A. S. G.

Indian Standards Institution, Thirteenth Annual Report (Indian Standards Institution (ISI), Manak Bhawan, New Delhi-11), 1959-60. Pp. 127. Price Rs. 2.

The Indian Standards Institution was set up in 1947, in pursuance of a decision of the Government of India, for the purpose of preparing and promoting standards for Indian Industry. The objects of ISI include the preparation, promotion and general adoption, at the national and international levels, of standards relating to materials, commodities, structures, practices and operations. It promotes quality control methods, and provides for the registration of Standard Marks conforming to standards issued by it.

The *Thirteenth Annual Report* which we have received contains in detail the work of the various Divisions of the Institution during 1959-60. A perusal of the report shows a rapid increase in the activities of the Institution. During the year 216 new standards and 22 revised stand-

ards were issued by the ISI as against 196 in the previous year.

Books Received

Quantum Mechanics By J. L. Powell and B. Crasemann. (Addison-Wesley Publishing Co., Reading, Mass., U.S.A.), 1961. Pp. x + 495. Price \$ 9.75.

Selected Papers on Stress Analysis The Institute of Physics Stress Analysis Group Conference, Delft, 1959. (Chapman and Hall, 37, Essex Street, London, W.C. 2), 1961. Pp. 114. Price 50 sh.

Introduction to Probability and Random Variables By G. P. Wadsworth and J. G. Bryan. (McGraw-Hill Book Co., 330, West, 42nd Street, New York), 1960. Pp. viii + 292. Price \$ 8.75.

The Chemistry of Heterocyclic Compounds (Vol. 15) Heterocyclic Compounds with Bridgehead Nitrogen Atoms (Part 1) By William L. Meiss. (Interscience Publishers, 250, Fifth Avenue, New York-1), 1961. Pp. 747. Price \$ 48.00; Subm. \$ 43.00.

The Indian Ephemeris and Nautical Almanac for the Year 1962 (Nautical Almanac Unit, Regional Meteorological Centre, Alipore, Calcutta-27), 1961. Pp. xxviii + 460. Price Rs. 14.

Cambridge Monographs in Experimental Biology, No. 11 Intermediary Metabolism Plants By David D. Davies. (The Cambridge University Press, 200, Euston Road, London, N.W. 1), 1961. Pp. xii + 107. Price 20 sh.

Applied Thermodynamics By S. H. Broadbent (D. Van Nostrand Co. Ltd., 368, Kensington High Street, London, W. 14), 1961. Pp. viii + 230. Price 30 sh.

The New Age in Physics By H. S. W. Massey (Elek Books Ltd., 14, Great James Street, London, W.C. 1), 1960. Pp. 342. Price 42 sh.

Progress in Cryogenics (Vol. 3) By K. Mendelsohn. (Heywood and Co. Ltd., London), 1961. Pp. 173. Price 45 sh.

Physics of the Solar Chromosphere (Vol. VI) By R. N. Thomas and R. G. Athay (Interscience Publishers, New York), 1961. Pp. x + 422. Price \$ 15.50.

Differential Equations By F. G. Tricomi (Blackie and Son Ltd., 16-18, William IV St., London, W.C. 2), 1961. Price 50 sh.

Boundary and Eigenvalue Problems in Mathematical Physics By Hans Sagan. (John Wiley and Sons, London; India: Asia Publishing House, Bombay-1), 1961. Pp. xviii + 381.

SCIENCE NOTES AND NEWS

Seminar on Electrochemistry

The Third Seminar on Electrochemistry will be held during the third week of December 1961, at the Central Electrochemical Research Institute, Karaikudi.

Three copies of detailed abstracts of papers (not exceeding 300 words) proposed to be contributed may kindly be forwarded to the Convenor of the Seminar, Mr. V. Aravamuthan, Assistant Director, Central Electrochemical Research Institute, Karaikudi-3 (Madras State), not later than 15th September 1961 and two copies of the full papers by the 15th November 1961.

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board will consider applications for the award of Fellowships for research work on medical and allied subjects in recognized institutions situated in the Union of India. The awards normally consist of Rs. 3,000 per year for a Fellowship and Rs. 750 per year towards contingencies approved by the Board.

Applications in the prescribed form, which may be obtained from the Secretary and Treasurer, should be forwarded through the Guides, under whom research work will be carried out, and the Heads of the Institutions. Each application should be accompanied by six copies of a brief statement of the research project and the comments of the guide regarding the suitability of the project and the facilities existing at the Institution. Applicants should have an M.B., B.S. or M.Sc. Degree or its equivalent or not less than two years' experience in research work after B.Sc. The awards are made annually and may be renewed on the basis of satisfactory progress.

Application for grants for the year commencing January 1, 1962 should reach the Secretary and Treasurer, Raptakos Medical Research Board, Dr. Annie Besant Road, Worli, Bombay-18, before September 30, 1961.

Symposium on Carbohydrate, Cellulose and Cellulose Industries

The Chemical Research Committee of C.S.I.R. is organising a Symposium on Carbohydrates, Cellulose and Cellulose Industries on the 29th and 30th January, 1962 at the Ahmedabad

Textile Industry's Resear Ahmedabad-9.

The programme will consist and discussion of original rese following fields: (i) Chemistry of Carbohydrates; (ii) Physics of Natural Cellulosic Fibres; (iii) Technology of Cellulosic Fibres; Rayon Pulp and Cellulose Derivatives. workers are invited to corr Director, Ahmedabad Textile Association, Ahmedabad-9.

The Indian Pharmaceutical Congress

The Fourteenth Session of the Indian Pharmaceutical Congress will be held on December 29-31, 1961.

For particulars please write General Secretary, Indian Congress Association, 14, Avenue, Calcutta-13.

Micro Hydel Sets to Harness Power Generation

One of the significant developments in the field of power generation in India is the harnessing of hill streams fed by rivers, which are available in enough electric power for generating power in remote areas in the country. Second Plan a micro hydroelectric scheme was installed at Chaila, in Himachal Pradesh, on a experimental basis, for harnessing the power of the Giriganga, about 18 km. This power house has been made operational for electricity from the near-kilometre long river. A second set is being installed at Chaila, in Chamba District and a third set is planned for Chini in 1961-62. In the Plan period, it is proposed to install 10 sets in Himachal Pradesh. The cost per unit of power generated by these micro sets is low—a few rupees per unit. They operate either unattended or with a small line staff for continuity of supply. The Government of India has taken steps to encourage the setting up of such power houses in the country.

Gamma-Radiation to Control Beetles

British timber experts have found the possibility of controlling the spruce beetle by gamma-radiation treatment.

Blocks of oak sapwood containing spruce beetle larvae were given dosages varying from 100 to 200 rads.

to 8,000 roentgens. Some beetles survived the 4,000-roentgen treatment and subsequently emerged and laid eggs, but only a few of the eggs hatched. However, the stronger dosages (6,000 roentgens upwards) appeared to be fatal, as no beetles emerged from the treated blocks.—(British Information Services.)

New Standard for the Metre

In its original conception the meter was the fundamental unit of the metric system, and all units of length were to be derived directly from the meter which was intended to be equal to one ten-millionth of the earth's quadrant.

In October 1960, it was agreed at the Eleventh General (International) Conference on Weights and Measures to redefine the meter in terms of the wavelength of the orange-red radiation in vacuum of krypton 86 corresponding to the unperturbed transition between the $2p_{10}$ and $5d_5$ levels as follows :

$$1 \text{ meter} = 1,650,763.73 \text{ wavelengths.}$$

This corresponds to a wavelength (krypton 86 orange-red) of

$$6,057.8021 \times 10^{-7} \text{ millimeter.}$$

Thus, as for more than 150 years, the meter bears no definite relation to the earth's quadrant. From the time of the adoption of the International Prototype Meter in 1889, the meter had been defined in terms of that standard, a platinum-iridium bar kept at the International Bureau of Weights and Measures in Sevres, France, suburb of Paris. At the Seventh General Conference in 1927 a supplementary relation between the meter and the wavelength of light was adopted. This relation for red cadmium light waves under specified conditions of temperature, pressure, and humidity was :
 $1 \text{ meter} = 1,553,164.13 \text{ wavelengths.}$ This corresponds to a wavelength (cadmium red) of $6,438.4696 \times 10^{-7} \text{ millimeter.}$ The number of wavelengths of the krypton 86 radiation in one meter, 1,650,763.73, was obtained by comparing interferometrically orange-red krypton 86 radiation with the red cadmium radiation.

The above is extracted from the latest publication *Units of Weights and Measures*, National Bureau of Standards Miscellaneous Publication 233 (Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.), 1960, 20 pages, 40 cents.

Effects of High Pressure on Glass : A Possible Piezometer for the 100-Kilobar Region

The measurement of pressures of the order of 10,000–200,000 bars and upward on uniaxial pressure transmitting devices is a formidable

problem. At present, high-pressure calibration devices depend on the temperature-dependent phase transitions which occur in some metals. This is unsatisfactory, since it allows only point-wise calibration over a limited range of pressures and is limited to the room-temperature 'fixed' points.

Bridgman and Simon found that silica glass could, above a threshold pressure of about 100,000 atmospheres, be made permanently more dense and at pressures of about 200,000 atmospheres this increase in density amounted to about 6-7%.

In their recent investigations of the problem Rustom Roy and H. M. Cohen find the effect of pressure on the density and refractive index of silica glass to be much greater than that reported by Bridgman and Simon. Further, the change in density was found to be a continuous function of pressure above 20,000 atmospheres at room temperature. No threshold effect was observed at 600°C. The density of silica glass, which has a normal refractive index of 1.458, could be increased by a pressure of 150,000 atmospheres at room temperature to a form with a refractive index as high as α -quartz, namely, 1.54. The changes achieved by Bridgman and Simon at a reported pressure of 200,000 atmospheres could be achieved at pressures as low as 55,000 atmospheres at room temperature.

In view of the observed continuous increase of density of silica glass as a function of both temperature and pressure, it is proposed that the refractive index of silica glass be used as a piezometer. Silica is particularly inert and could be mixed with many samples to provide a check on the actual pressure and/or temperature of a run. It is suggested that it would be quite valuable if several laboratories interested in high-pressure measurements determined independently the effect of pressure and temperature on the refractive index of silica glass. Perhaps a satisfactory pressure-scale could then be agreed upon.—(Nature, 1961, 190, 798.)

Element 103, Lawrencium

A group of nuclear scientists of the Lawrence Radiation Laboratory, University of California, succeeded in obtaining the new element 103 by bombarding californium with boron nuclei B^{10} , B^{11} , in the laboratory's heavy-ion linear accelerator. The name *Lawrencium* has been proposed to the new element in honour of E. O. Lawrence, the inventor of the cyclotron and founder of the laboratory which bears his

Californium (element 98), used as the target material in the synthesis of the new element, is obtained by prolonged irradiation of transuranium elements in a nuclear reactor by the successive addition of neutrons. Since each new heavy element is more unstable than the one before, neutron addition method will become increasingly inapplicable, and heavy-ion bombardment is the more promising route whereby heavy elements may be created. Even by this method it is improbable that elements beyond 105 will be produced and identified, because of their extreme instability and of the very small number of atoms formed in the reaction.

The discovery of Lawrencium, the eleventh new man-made element after uranium (92), was announced on April 13, 1961 by the University of California and the U.S. Atomic Energy Commission.

Hydrogen Lines in the Infra-Red Spectrum of the Sun from High-Flying Aircraft

Solar spectra taken with a high-resolution spectrograph from an aircraft flying at altitudes of 30-40 thousand feet have revealed the presence of atomic hydrogen lines in the infra-red due to absorption in the solar atmosphere. Two of these lines occurring in the water-vapour band 1.9μ have been identified as the first line of the Paschen series (electronic transition 3-4) and the fourth line of the Brackett series (4-8). Another solar line that has been detected is the second line of the Brackett series (transition 4-6), lying in the 2.6μ water band.

These features have been experimentally observed for the first time. They are not revealed in the solar spectrum taken from ground level on account of the strong absorption in the infra-red region shown by the constituents of the earth's atmosphere. Even in spectra taken at mountain observatories these lines are obscured by the water-vapour absorption.

The intensity of these lines have been observed to be the same on spectra taken at

different high altitudes thus confirming their solar origin.

In calculating water-vapour concentrations from absorption photometry due account should be taken of the presence of these lines.—(*Nature*, 1961, 189, 908.)

Infra-Red Physics—An International Research Journal (Vol. 1, No. 1). (Pergamon Press Ltd., Headington Hill Hall, Oxford), March 1961. Annual Subscription £ 7. (\$ 20.00).

This new journal is being established as an international forum for the publication of scientific papers devoted to infra-red physics and its applications. It is concerned with infra-red theory, experiment, and instrumentation as applied to infra-red detection and transmission and to problems of atmospheric, meteorological, geophysical, astrophysical and space research.

Fittingly enough the first number of the journal opens with an article on the life and work of Sir William Herschel. Among the other articles in this issue are: "A status report on infra-red detectors" by P. Bratt, W. Engeler, H. Levinstein, A. MacRae and J. Pehek; "Interferenz-Modulation mit monochromatischen Millimeter-Wellen" by H. Happ and L. Genzel; "Sunseeker for high-altitude infra-red solar spectra" by P. A. Lapp and H. S. Kerr; "Infrared photography using persistent internal polarization in phosphor plates" by H. Kallmann, J. Rennert and M. Sidran; "The theory of thermal imaging, and its application to the absorption-edge image-tube" by C. Hilsum and W. R. Harding.

The annual subscription is £ 7 (\$ 20.00) for institutions and £ 3-10 sh. (\$ 10.00) for individuals.

ERRATUM

In the June, 1961, issue of *Current Science*, on page 224, column 2nd, paragraph 2nd, the 5th line should read as 'C. neoformans from the sputum of a human case' and not, 'C. diffuens, C. laurentii and C. kuteolus to be'.

481-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00 ; £ 1-4-0 ; \$ 4.00.

THE COLOUR OF THE SEA

THE colour exhibited by the large masses of water present in oceans, seas and lakes is a spectacular phenomenon. Apart from its interest from the standpoint of optical theory, it is also a subject of practical importance. The existence of various forms of life in deep water depends not a little on the amount and nature of the sunlight which penetrates to its different depths. There can be no doubt that the physics of the sea plays as important a role in the life of the pelagic flora and fauna as the physics of the atmosphere does in the case of terrestrial plants and animals.

Remarkably enough, so great an authority on optics as the first Lord Rayleigh in a published lecture on the colours of sea and sky expressed the opinion that the much-admired dark-blue of the deep sea has nothing to do with the colour of water, but is simply the blue of the sky seen by reflection. But other observers, as for example, the late J. Y. Buchanan of the "Challenger" Expedition who had wide opportunities for study published detailed descriptions which supported an entirely contrary view. The general trend of opinion in the early years of the century was that so far as there was any real effect to be explained at all (that is apart from reflected skylight) the colour of water is due to absorption, the return of light from the depths of the liquid being due to the presence of suspended matter in it.

A fundamentally new approach to the subject of the colour of the sea was put forward by Sir C. V. Raman in a memoir which was published in the *Proceedings of the Royal Society of London for April* 1922. This publication was the result of observational studies made by him during a steamer voyage covering the Mediterranean and Red seas and over the Indian Ocean made in the preceding year, as also of laboratory studies made subsequently and of mathematical calculations based on the results of his experiments.

The starting point for Raman's work was furnished by the celebrated investigation published in the year 1910 by Einstein who gave a quantitative formula for the intensity of the opalescence exhibited by fluids in the vicinity of their critical temperatures. Raman argued that fluctuations of density of thermodynamic origin and consequent variations of refractive index similar to those considered by Einstein but of a far smaller order

of magnitude should also appear in liquids at ordinary temperatures. They would result in an observable diffusion of light the intensity of which would be determined by the compressibility and the refractive index of the liquid. Calculations based on Einstein's formula showed that the intensity of such diffusion in dust-free water would be very much smaller than if the molecules of the liquid scattered light independently of each other. Nevertheless, the diffusion should be readily observable and in the case of large water masses could give rise to spectacular effects.

Laboratory studies made by Raman at Calcutta following his voyage confirmed his anticipations and showed that water rendered dust-free by prolonged settlement does indeed diffuse light of a blue colour and of an intensity of the order of magnitude indicated by the formula. It was these observations which then led Raman to consider the subject of the diffusion of light also from a wider standpoint. He proceeded to study the scattering of light in transparent media of all sorts, in diverse physical states and of diverse chemical composition. His essay on the molecular diffraction of light published in February 1922 contained a report on the preliminary results of this exploration. This essay foreshadowed the subsequent investigations spread over a period of years which led Raman to the outstanding discovery made by him in February 1928 of the effect known by his name and which were recognised by the Nobel award in December 1930.

Returning to the subject of the colour of the sea, Raman's paper referred to above covered the varied facets of the subject revealed by his own observations at sea and by those reported by Buchanan and other earlier writers. Water, as was well understood at the time, has a specific absorption of its own which extends well into the visible region but weakens and becomes almost imperceptible towards the blue end of the spectrum. As the light of the sun deeply penetrates into a mass of water, this absorption would come into play. The part of the spectrum in which it operates would thereby be enfeebled, while in the part where the specific absorption is weak, it would be supplemented by the progressive extinction arising by reason of the thermodynamic diffusion of the beam of light. Likewise, the light diffused in the interior of the liquid and travelling upwards towards the

surface would be enfeebled by the specific absorption as well as by the thermodynamic extinction. The colour of the light finally emerging from the surface of the liquid and perceived by the observer would be determined firstly by the selectively stronger diffusion of the shorter wavelengths and secondly by the processes of absorption and extinction referred to above.

Calculations based on the foregoing considerations were presented of the spectral composition of the colour of deep water as perceived by an observer above its surface, the standard of comparison being the light scattered by dust-free air which, as is well known, is itself of a blue colour. The results showed that the cutting out of the red and the enfeeblement of the orange and yellow by reason of the specific absorption by water would result in the light emerging from the surface being of a highly saturated blue colour. It was also remarked that the enfeeblement of the orange and yellow would considerably diminish the visible intensity of the light emerging from inside the liquid.

The foregoing discussion refers to the ideal case of water which is chemically pure and free from suspended matter of all sorts. Raman considered in detail the modifications that would result from the presence of suspended matter. He remarked that the large differences observed in the colour of oceanic waters ranging from a deep olive-green through ultramarine and finally to a deep indigo could reasonably be explained as consequences of the variation in the nature, quantity and state of dispersion of the suspended matter present in the waters exhibiting these different colours.

Raman's paper also dealt in considerable detail with the variations of the colour of the sea resulting from the altitude of the sun and with the influence of multiple scattering within the fluid. He also described observations on the state of polarisation of the light emerging from inside the sea in various circumstances. He further discussed the effect of skylight on the appearance of the sea which results from the reflection at its surface at various angles of observation.

Summing up, we may say that Raman's paper of April 1922 not only established the reality of the phenomenon of the colour of the sea, which at the time was popularly regarded as being merely the reflection of skylight, but also placed its explanation on a firm foundation of accepted physical theory and demonstrable experimental fact. No publication that has since appeared on the subject has added anything really fundamental to the ideas set out in his paper, but only dealt with matters of detail relating to particular cases and particular circumstances. It might therefore be said that just as the theory of the colour of the sky is formally associated with the name of the late Lord Rayleigh, the explanation of the colour of the sea and of great masses of water generally should likewise be permanently associated with the name of Sir C. V. Raman. This was formally recognized by no less an authority than the late Sir William Henry Bragg who in his book *The Universe of Light* which is deservedly one of the most popular expositions of optics ever published devotes two pages to the explanation of the colour of the sea and gives the fullest credit to Sir C. V. Raman as having given the proper explanation of the phenomenon.

A. S. GANESAN.

NEW CARBON ISOTOPE, CARBON-16

A NEW carbon isotope of mass 16 has been discovered by physicists of the Atomic Weapons Research Establishment, Aldermaston, working in collaboration with scientists of the Clarendon Laboratory, Oxford. A carbon-14 target was bombarded with a beam of 6 MeV. tritons (ions of tritium) from the Aldermaston Van de Graaff accelerator. In some cases, the force of the collision was observed to be sufficiently great to split the triton into its constituents of one proton and two neutrons and the neutrons were captured by the carbon-14 to form a new

isotope, carbon-16. By making precise measurements with a large magnetic spectrograph on the emitted protons, the mass of the new isotope was found to be 16.014702 atomic mass units. It was anticipated that carbon-16 would suffer beta-decay like carbon-14 and carbon-15, but with the difference that the product of the decay would still have sufficient energy to emit a neutron. This occurred, and use was made of this property to measure the half-life, which was found to be 0.74 sec.—(*Nature*, 1961, 190, 586.)

PREPARATION OF FLAVYLIUM SALTS OF THE ANTHOCYANIDIN TYPE

H. G. KRISHNAMURTY AND T. R. SESHADRI

(From the Department of Chemistry, Delhi University, Delhi-6)

(A) PELARGONIDIN GROUP

FOR the past few years we have been interested in working out convenient methods for the preparation of anthocyanidin chlorides needed for biological investigations and also in studying the interconversion of flavonoids. Flavonols are easily available as natural products and they can also be readily prepared pure by laboratory synthesis. Their conversion into anthocyanidins has been investigated for a fairly long time. The earlier experiments of Willstätter,¹ Robinson² and others were not fully successful from the point of view of yield and purity of the products. More recently King and White³ reported that they could obtain good yields of cyanidin (III) from quercetin (I) by the method of reductive acetylation using sodium acetate, acetic anhydride and zinc; similar conversion was effected using other flavonols. We had occasion to study this method closely and find it useful. The intermediate seems to be the corresponding flav-3-ene-3-ol acetate⁴ (II) which undergoes conversion into the anthocyanidin on boiling with alcoholic hydrochloric acid. But the anthocyanidins were impure and showed absorption maxima lower by 15–20 m μ as compared with standard samples. The impurities responsible for this lowering can be removed by paper chromatographic purification.⁵ But this is a tedious process and not suitable for preparative work. However, after the conversion into anthocyanidins if the acid solution is extracted once with ethyl acetate or several times with ether, the impurities are largely removed. This is then followed by further purification using transfer into iso-amyl alcohol and retransfer into aqueous 1% acid. The products then exhibit the correct absorption maxima. With this modification in the isolation of the anthocyanidins, the reductive acetylation method can be used as a general method for the preparation of 3-hydroxyflavylium chlorides.

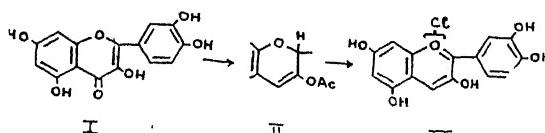
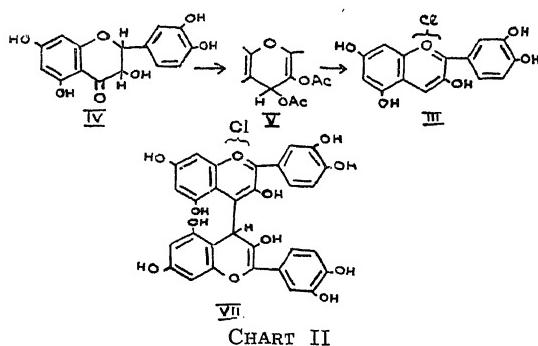


CHART I

In the course of the study of the mechanism of the reductive acetylation we examined the

behaviour of dihydroflavonols and obtained varying results in the nature of the resulting products in different experiments. As a cause of this discrepancy the possibility of initial dehydration of the dihydroflavonol and subsequent reductive acetylation of the flavone derivative was envisaged. To check this point taxifolin (IV) was boiled with acetic anhydride (i) without a base catalyst and (ii) with sodium acetate or pyridine. In the first case the product yielded only taxifolin penta-acetate. In the second case there was development of deep colour within 30 minutes of heating and at the end of the experiment, the product was found to be a new acetate; it was eventually discovered that under these conditions taxifolin undergoes an intramolecular rearrangement leading to the formation of cyanidin pseudo-acetate (V).⁵ Subsequent deacetylation preferably with cold alkali (2%) led to the preparation of cyanidin (III). The experiments could be repeated with aromadendrin and dihydrorobinetin giving pelargonidin and robinetinidin respectively. This transformation is significant from the point of view of biogenesis of anthocyanidins because it shows that under suitable conditions a dihydroflavonol can directly give the corresponding anthocyanidin. The importance of dihydroflavonols as vital intermediates in the biogenetic evolution of flavonoids has already been emphasised.⁶ The new result is a further addition to the possible transformations of dihydroflavonols.

Recently Prof. Pacheco has drawn our attention to his papers⁷ dealing with a colour test for dihydroflavonols; the test consisted in heating the compound with acetic anhydride and sodium acetate, followed by hydrolysis with hydrochloric acid when a red colour extractable by isoamyl alcohol is produced. This colour test has been used by him for the detection of dihydroflavonols in plant materials. On the lines of earlier work of Nierenstein⁸ on the reduction of flavonols, Pacheco considered the colour to be due to dimeric forms (VII) and not due to anthocyanidins. Our recent work⁵ done independently from another direction has clarified in detail the nature of the intermediate acetate and of the colouring matter derived from it and has led to a very convenient and efficient method of converting a dihydroflavonol into the corresponding anthocyanidin.



(B) GESNERIDIN GROUP

Flavylium salts related to flavones, though not so numerous as those related to flavonols, seem to occur in fair number. Among them, gesneridin⁹ was probably the only example (occurring as glycoside) known till 1934, but recently luteolinidin¹⁰ and 5 : 7 : 3' : 4' : 5'-penta-hydroxyflavylium chloride¹¹ have been added. This group of anthocyanidins exhibits great tendency to form anhydro colour bases and some of them are found only in this form.¹² Convenient methods for their preparation starting from flavones and flavanones are therefore useful. Flavanones undergo easy and quantitative reduction with sodium borohydride or lithium aluminium hydride to give flavan-4-ols; the use of the first reagent is simpler. These flavan-4-ols representing a simpler type of leucoanthocyanidins are converted into the corresponding flavylium chlorides when heated with hydrochloric acid in alcoholic solution. By the usual partition method of purification, the anthocyanidins can be obtained in an over-all yield of 10-15%. Slightly increased conversion could be effected by carrying out the transformation under anhydrous conditions. As representative examples apigeninidin (gesneridin X) and its O-trimethyl derivative have been prepared and their identity proved by comparison with standard samples synthesised by the method of Robinson. Unlike 3-hydroxyflavanones (dihydroflavonols), flavanones without the 3-hydroxyl do not undergo the base catalysed isomeric change mentioned above. No definite reasons for the failure can be given. It may be that appropriate conditions have yet to be found out.

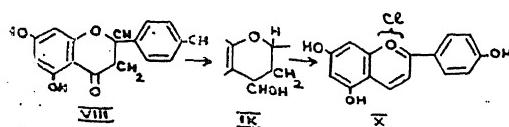


CHART III

The reductive acetylation method has now been extended to flavones and flavanones. It works well with a number of hydroxy- and methoxyflavones and gives good yields (40-50%) of chromatographically and spectrophotometrically pure flavylium chlorides; unlike the experiments with flavonols there is no difficulty of purification here. In a detailed study of apigenin (XI) and its methyl ether, the product of reductive acetylation seems to consist of a difficultly separable mixture of flav-3-ene (XII a) or flav-2-ene (XII b) and flavan-4-ol (IX) derivatives as could be judged from light absorption studies. The high yield of the anthocyanidin obtained is most probably due to the presence of a high percentage of flavene in the mixture.

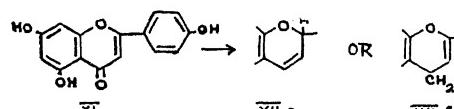


CHART IV

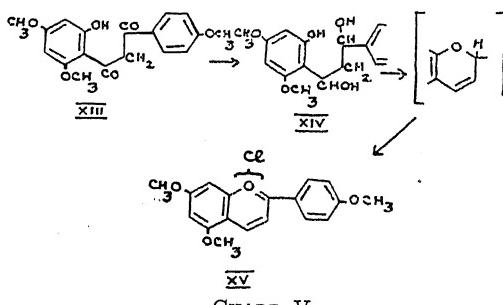


CHART V

As a simplification in steps, the use of 2-hydroxydibenzoylmethanes related to flavones has also been examined for the preparation of flavylium salts. These diketones are now easily available by the Baker-Venkataraman transformation of 2-aryloxyacetophenones. 2-Hydroxy-4 : 4' : 5'-trimethoxydibenzyl methane (XIII) underwent complete reduction with sodium borohydride to give the diol (XIV) which is sensitive to mineral acid and gives a deep pink colour in cold alcoholic acid solution. This colour, however, is not stable and changes to red. The diol slowly undergoes change into the corresponding anthocyanidin and some polymeric products. However, apigeninidin trimethyl ether (XV) can be obtained in an yield of about 40% by carrying out this conversion with a mixture of glacial acetic acid and concentrated hydrochloric acid or by saturating the benzene solution of the diol with hydrogen chloride gas. This reaction seems to be of general nature.

The flavylium ferric chloride was directly obtained by performing the above conversion in the presence of anhydrous ferric chloride.

Reductive acetylation of flavanones using as examples naringenin and its trimethyl ether has not so far yielded satisfactory results.

1. Willstätter, *Sitzber. Preuss Akad. Wiss. (Berlin)*, 1914, 769.
2. Robertson and Robinson, *J. Chem. Soc.*, 1927, 2196.
3. King and White, *J. Chem. Soc.*, 1957, 3901.
4. Laumas and Seshadri, *Proc. Ind. Acad. Sci.*, 1959, 49A, 47.

5. Krishnamurty, Seshadri and Venkataramani, *J. Sci. Ind. Res. (India)*, 1960, 19B, 116.
6. Seshadri, *Tetrahedron*, 1959, 170.
7. Pacheco and Chadenson, *C.R. Acad. Sci. (France)*, 1956, 242, 1621; *Chem. Abs.*, 1956, 50, 16,564 a; *Ibid.*, 1957, 14199.
8. Malkin and Nierenstein, *J. Amer. Chem. Soc.*, 1930, 52, 2864.
9. Robinson, Robinson and Todd, *J. Chem. Soc.*, 1934, 809.
10. Harborne, *Chem. and Ind.*, 1960, 229.
11. Roberts and Williams, *J. Sci. Fd. Agri.*, 1958, 9, 217; Egli et al., *J. Chromatogr.*, 1959, 2, 173.
12. Seshadri, "Naturally occurring quinonoid anhydro bases. *Festschrift Arthur Stoll*," *Experientia*, 1956, 318.

THE BENGUELA CURRENT*

THE prime object of all marine research is the rational exploitation of available fish stocks and in the course of such investigations considerable essential knowledge on the fundamental aspects has also been accumulated. The reports based on the work done by R.R.S. *Discovery* and R.R.S. *William Scoresby* and published in the "Discovery" Rep. have considerably advanced our knowledge of the large water masses in the Southern Hemisphere in this regard. The present report based on the two surveys by R.R.S. *William Scoresby* deals with the water masses on the West Coast of South Africa about which not much is known.

The title might give one the impression that the account is mainly hydrographical and it may be stated at the outset that the authors have striven to make the report as complete as possible dealing with the biological aspects as well—phyto- and zoo-plankton, fishes, etc.

The report opens with an account of the earlier work in the region and environs, and describes the methods and itineraries of the survey. After dealing with the topography of the coastal region of South-West Africa and of the sea-floor, etc., the authors describe the prevailing winds, circulation of water, define what constitutes the Benguela Current, mechanism of upwelling and so on. The distribution of temperature, salinity, phosphate- and dissolved oxygen-content is shown and the effect of the last on fish life is pointed out. Decomposition of organic matter on the sea bed leads to further enrichment of the already phosphate-rich upwelled water.

The distribution of micro-plankton particularly the Diatomaceæ and its frequency of occurrence and dominance as well as the distribution elsewhere of the typical Benguela Current species are given. The zoo-plankton of Survey I alone

is dealt with ; its interesting feature appears to be its greater independence of specific water masses than the phytoplankton and conspicuous patchiness in the distribution of some species. The phenomenon of discolored water caused by Diatomaceæ and Dinophyceæ and Ciliate elements are mentioned and their possible significance in relation to mortality of fish fauna discussed. The authors also deal with other forms of life in the current, fish, seals and whales and a reference is also made to the spawning grounds of the South African pilchard and to Guano Islands which are all of economic importance. A passing mention is made to the organic production of Benguela Current. It is found that many features of this Current are similar or analogous to other upwelling regions on the Western Coasts of North and South America and Africa, regions which are known to be fertile as regards organic production.

Though like all expedition reports the one under review also suffers from lack of continuity of observations over a period of time (this is inevitable in a survey of such nature) the wealth of information contained therein is immense and valuable and the account, well presented and illustrated, will be welcomed by all interested in the study of the seas.

R. SUBRAHMANYAN.

* By T. John Hart and Ronald I. Currie, "Discovery" Reports, 1960, 31, 123-298. Issued by the National Institute of Oceanography. (The University Press, Cambridge). Price 75 sh. net.

† Also Madras Coast, for instance, in the Indian region. Incidentally, it may be mentioned that a large number of Benguela Current species has also been recorded on the West Coast of India (R. Subrahmanyam, *J. Indian bot. Soc.*, 1958, 37, 435-41).

‡ The West Coast of India may also be included in this category (vide R. Subrahmanyam, *Proc. Ind. Acad. Sci.*, 1959, 50, 113-252).

USE OF IONISING RADIATIONS FOR FOOD PRESERVATION

E. S. BROADBRIDGE

Member of the Society of Radiographers, London

THE search for new and improved methods of extending the storage life of food is a never-ending task for chemists, physicists and food technologists. Ever since it became known that radiation in the form of X-rays could destroy or inhibit the growth of cell tissue, experimental work has been going on in the use of radiation to kill the spoilage organisms in certain foods.

These experiments have met with varying degrees of success and the present position is encouraging, but the end of the road has not yet been reached.

In general, the radiation used is obtained from one or two sources; high speed electrons produced by electrical machines such as the Cockcroft-Walton generator or the linear accelerator, or "gamma rays" (which are similar to X-rays) produced by radioactive isotopes.

Use of radiation doses sufficiently large to sterilise meat (that is to kill all the normal spoilage bacteria) often results in unacceptable changes in colour, odour or taste, and so later experimental work has concentrated on giving a much lower "pasteurising" dose which serves to extend the storage life by a factor of three to five without the ill effects of the higher dosage.

NUTRIENT VALUES COMPARED

Chemical tests show that the nutrient value of irradiated food is no less than that of similar food which has been preserved by a heat treatment, and, in fact, volunteers in the U.S.A. have lived on a complete diet of such food for short periods. Animals have been fed on irradiated foods for more than one generation and no effect has been found on longevity or reproduction.

Owing to the high level of radiation at the processing point, strict control of the personnel employed is necessary and the radiation source must be properly screened to prevent the escape of dangerous radiation. It is expected, therefore, that when radiation processing becomes a commercial possibility, food will be taken to large packaging and radiation processing centres rather than being treated in small factory units. There is no danger of residual radioactivity in the food.

Waste radioactive material from nuclear power stations has been used for some food irradiation work, but economically there are serious disadvantages to the use of the material. Although regarded as waste material at the reactor, these fission products are extremely

expensive to transport to the processing centre due to the heavy protective containers required. Another radioactive material, Cobalt 60, is also sometimes used for food irradiation. When these sources are used, the radiation given off continuously in all directions cannot be controlled except by removing the radioactive source from the vicinity of the processing line and placing it in a suitable "safe" place. Further, these sources produce radiation in the form of gamma rays which tends to pass through the product without being fully absorbed, and in order to receive the correct dose an extremely complicated handling system is required which passes the food on multilayer conveyor belts around the source.

Free electrons give the ideal method of irradiation provided that the beam used has sufficient energy to ensure effective dosage of the products from one, or both sides. The present form of food packaging in small units lends itself well to electron irradiation and the electrical machine, which can deliver a controlled, directional beam of electrons through the products, gives a much more efficient utilisation factor than the use of radioactive isotopes.

DIRECT AND INDIRECT ACCELERATORS

Electrical machines fall broadly into two classes —direct accelerators and indirect accelerators. The first type requires a very high electrical potential between an anode and cathode. Thus the energy level from machines of this sort is limited by insulation problems, and energies of three million electron volts in a simple machine represent the upper limit.

For the production of electrons above these energies indirect accelerators must be used. In this type of machine the necessary acceleration is obtained without the use of very high potentials. Where a large output of electrons at a high energy level is required the microwave linear accelerator is ideal. This machine uses radiofrequency waves to accelerate the electrons along a specially constructed waveguide.

Recent developments have produced reliable linear accelerators with a built-in safety system to protect both operator and machine in the event of incorrect operation. The machine can be mounted vertically over the conveyor belt for one-sided irradiation or horizontally with a device to split the electron beam for treatment on both sides of the product.

Further developments in valve technology have produced klystron valves which, when used to power a linear accelerator, will give many kilowatts of electron output at energies of 10 to 25 MeV.

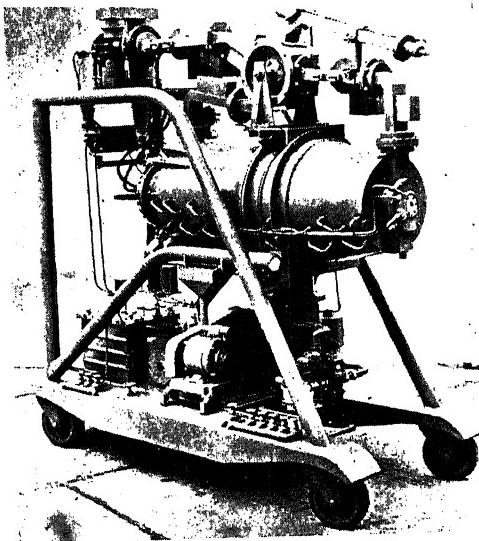


FIG. 1. The Mullard 4.3 MeV Travelling Wave Accelerator.

To assess the output and energy required to treat a given volume of product the following factors have to be assessed :—

1. *Thickness of Product.*—Electron penetration into unit density material is approximately half a centimetre per MeV so that to irradiate from one side a package 10 centimetres thick would require an electron energy in excess of 20 MeV. If the product were irradiated from both sides, an energy of only 12 MeV would be required.

2. *Utilisation Factor.*—This factor deals with the most efficient use of the electron beam. Electrons leave the machine in a narrow beam through a thin metal window, and in order to cover a conveyor belt, need to be scanned over the belt to achieve a uniform dose distribution in the product. A typical utilisation factor for flat packaged food products could be as high as 70% using double sided irradiation.

3. *Dose.*—This represents the amount of radiation necessary to achieve the desired result and is measured using a unit known as the "rad". This is defined as the dose corresponding to the absorption of 100 ergs per gram of irradiated material. In practice, doses used are measured in terms of millions of rads (the megarad) and as an example the pasteurisation of food requires a dose of about 0.1 to 0.5 megarads.

Combining these factors it is possible to calculate the amount of food which can be processed in a given time by any machine.

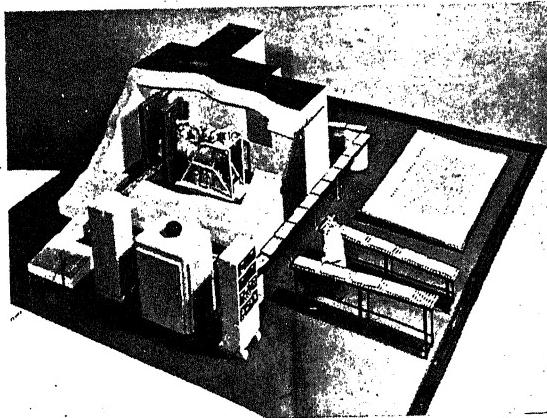


FIG. 2. The Mullard Accelerator being used to irradiate packaged foods.

Scientists working on food irradiation throughout Europe are now co-operating to combine the results of their work. Information is also fully available on the much wider programme in the United States so that the many problems still remaining should be solved more quickly.

FIRST APPLICATIONS OF PROCESS

Three specific uses of radiation in food processing have proved extremely successful* and it is likely that these will be the first commercial applications of the process.

Root vegetables, such as potatoes, deteriorate in storage by the production of sprouts which take nutrient from the tubers and make them useless as food. A small dose of radiation will prevent potatoes from sprouting and the keeping time can be extended up to fifteen months.

Certain foods are liable to contain specific undesirable organisms such as *trichinella spiralis* in pork and *salmonellæ* in frozen or dried egg. Both of these organisms are responsible for serious food poisoning and it has been found that comparatively low doses of radiation can destroy them without damage to the product itself.

Grain is attacked by insects during storage and again it has been found that beetles and grain weevils are destroyed by small doses of radiation, but at present the problem of treating grain in very large quantities has not been solved.

The outlook for radiation processing of food is very promising but much work remains to be done. No irradiated food will be available to the public until an exhaustive series of tests

has proved that the food is safe for general consumption and its nutritive value has not been impaired. Legislation in the U.K. which already protects the public from the use of dangerous preservatives, assures that radiation, which is regarded legally as a preservative, will not be used until all the resources of analytical chemis-

try, biochemistry, pathology and ¹¹ have approved a long series of test food. When these are satisfied, radi¹¹ ccessing may solve one of the most se¹¹ mblems of mankind—that of assuring ¹¹ food supply at all seasons.—(Courtesy Information Service.)

NATIONAL PHYSICAL LABORATORY (ENGLAND), ANNUAL REPORT F

PIONEERING research in a number of import-
ant branches of physics is reported in the National Physical Laboratory's report for 1960. They include work on ultra-high pressures, physics of high polymers, autonomics, and noise measurements and control.

A combination of pressures up to 100,000 atmospheres and high temperatures can cause profound and permanent changes in the properties of certain substances. Using an ultra-high pressure apparatus built at NPL to a modified American design, the Basic Physics Division has carried out studies of the effect of pressure on the resistivity of semiconductors, and produced coesite, a dense form of silica, and some very small artificial diamonds.

Polymers are widely used as plastics, synthetic rubbers and fibres and it is of great practical importance to discover the relationship between the structure of their long chain molecules and their electrical and mechanical properties. Work has continued during the year on measuring the dielectric properties and the low frequency dynamic properties of polymers.

Control of complicated industrial processes, such as the distillation column in an oil refinery, may be optimised by special computers permanently attached to plants and "learning" as the inputs and demands change. The first steps have been taken, with encouraging results, towards the building of an exceptionally fast analogue computer of such a kind. The high speed computer group is working on the development of the planar cryotron as a computing component. This gives promise of higher speeds, greater reliability, and smaller size for computers of the future. The division is also working on the mechanical translation of scientific Russian into English, automatic retrieval in libraries and automatic reading of both printed and hand-written numerals.

Subjective tests on motor vehicle noise are being made in the Applied Physics Division in collaboration with the Ministry of Transport, aimed at designing an instrument which will give a physical measurement of subjectively assessed noise for a wide range of vehicles. With

the help of 1,300 Open Day visitors. ment on the unpleasantness of noises was carried out last year whether unpleasantness can be used rion of judgment and if there is un judgment between different people.

Most of the work of the Aerodynamics section consists of fundamental research dynamics needed by the aircraft. Hypersonic flow now forms a large and research has also continued on slender and delta wings.

A crucial experiment in the Light was the attempt to measure light as "weighted" radiation. This is radiation has been passed through a filter at every wavelength, a fraction prop the sensitivity of the eye at that. First results were very encouraging considerable interest. Further research field may lead to an absolute radiometer to the measurement of light. A small group has been formed to study lasers are new powerful sources of nearly matic light obtained by stimulating fluorescent crystals. The aim will out what factors control the light to build experimental lasers for pulse- nuous operation, which can be used applications. The new programme organized High Temperature Materials laboratory will include a greater concentrat materials of very high melting point.

Work in ferrous metallurgy by the Division, using the electron microscope, to make progress, and will have many applications. During the year pre some new research programmes in. They include a research development on high speed digital computers, a research reactor, to be sited at and one for a Van de Graaff electro- rator.

LETTERS TO THE EDITOR

ETCHING OF ANTIMONY SINGLE CRYSTALS

IN continuation of our work on studies of etched surface of bismuth single crystals,⁴ we report here our results on the etch phenomenon on single crystals of antimony. The experimental procedure was the same as described in our earlier work.⁴

The freshly cleaved specimen was chemically etched in a solution containing 3 parts HNO_3 + 9 parts tartaric acid + 1 part water, for one to several seconds. In the initial stage of etching triangular etch pits distributed at random were observed. Moreover, there were two distinct types of pits, viz., sharp triangles and rounded triangles. Rows of closely packed triangular etch pits with branching at some places (Fig. 1)

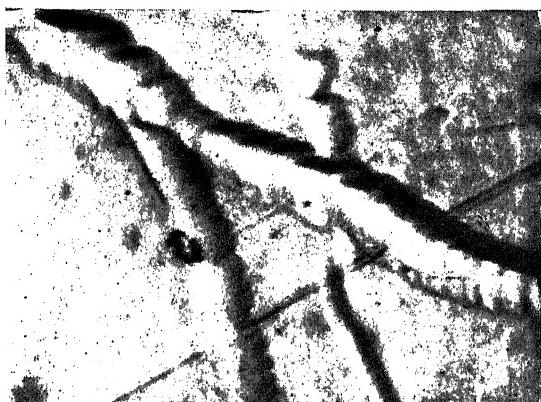


FIG. 1

were observed and with the increase in time of etching the pits became large and deep but the site of pits remained the same. The cleavage plane of the crystal was scratched quickly with a sharp needle and then subsequently etched in the above etchant. An array of triangular etch pits, lined up on many straight lines in a particular specified direction near the scratch, was observed. Dislocation etch pits have been observed on the cleavage plane of antimony produced by 3 parts HF, 5 parts HNO_3 , 3 parts CH_3COOH and 1 part Br_2 , (Lovell and Wernick)^{1,2} and by 10 gm. FeCl_3 , 30 ml. HCl and 120 ml. water (Shigeta and Hiramatsu).³ Among the different etchants tried by the authors the present etchant was found to be more suitable; in this case with the increase in etching

time the surface did not become tarnished and progressively dull as was the case with the other etchants used. One cleavage face was etched with one etchant and its counterpart was etched with another etchant and it was found that there was a close correspondence between the etch pits on both the faces. The etch pits obtained by the present etchant on cleavage (111) face of single crystal of antimony were similar to those obtained by earlier workers.^{2,3} Considering their orientation and density of distribution it seems that the etch pits are formed at dislocation sites.

The authors are thankful to the Council of Scientific and Industrial Research, New Delhi, for financing the research scheme and for the award of a Junior Research Assistantship to one of them (V. P. B.).

Physics Department,
M.S. University of Baroda,
Baroda, June 12, 1961.

N. S. PANDYA.
V. P. BHATT.

1. Lovell, L. C. and Wernick, J. H., *J. App. Physics*, 1959, **30**, 234.
2. Wernick, J. H., Hobstetter, J. N., Lovell, L. C. and Dorsi, D., *Ibid*, 1958, **29**, 1013.
3. Shigeta, J. and Hiramatsu, M., *J. Phys. Soc. Japan*, 1958, **13**, 1404.
4. Pandya, N. S. and Bhatt, V. P., *J. Sci. Industr. Res.*, 1960, **19 B**, 363.

FLUORIDE COMPLEXES OF URANIUM (IV) AND THORIUM WITH HYDRAZINE AND HYDROXYLAMINE

HYDRAZINE fluoride complex of uranium $\text{UF}_4\text{N}_2\text{H}_4\text{HF}$ has been isolated in this laboratory and will be reported.¹ The compound can be recommended as a suitable intermediate for the production of anhydrous uranium tetrafluoride. Though there is a close similarity between the physical behaviour of ammonia, hydrazine and hydroxylamine salts, so far no attempt has been made to prepare the corresponding hydroxylamine complex. The present note describes such an attempt for the preparation of the compound. When a mixture of uranyl-nitrate, hydroxyl amine, hydrofluoric acid is exposed to sunlight in presence of alcohol a green precipitate is obtained in about 10 to 15 minutes time and on further exposure more of the compound is formed. The compound on analysis has been found to possess the formula $\text{UF}_4\text{NH}_2\text{OHHF}$.

The compound on heating under vacuum at about 300°C. yields partially decomposed uranium tetrafluoride. The analogous hydrazine complex $\text{UF}_4\text{N}_2\text{H}_4\text{HF}$ on refluxing with formic acid gives uranium tetrafluoride. In this case, however, the hydrated tetrafluoride $\text{UF}_4\text{H}_2\text{O}$ was obtained.

A more expeditious method of preparation, as compared to the photolytic one, of the above mentioned complexes has been achieved, by the use of copper ion as catalyst for the purpose of reduction. With 2 gm. of uranyl nitrate, 1 gm. of hydrazine hydrochloride or hydroxylamine hydrochloride, 20-30 c.c. of 40% hydrofluoric acid and 5 drops N/20 copper sulphate solution, the yield of the product is 35% in about 10 minutes time at 80-90°C. The fluoride complexes are obtained in the pure form as bright-green dense crystals.

Thorium is known to form isomorphous compounds with that of tetravalent uranium with which it is associated in certain minerals. Attempt was therefore made to isolate the analogous thorium fluoride complexes. When hydrofluoric acid is added to a solution of thorium nitrate in presence of hydrazine or hydroxylamine a flocculent white precipitate is immediately formed. On raising the temperature to 70-80°C. the precipitate settles down in fine crystalline form. The compounds on analysis have been found to be isomorphous with the corresponding uranium (IV) complexes and possess the formulæ $\text{Th}_4\text{N}_2\text{H}_4\text{HF}$ and $\text{ThF}_4\text{NH}_2\text{OHFF}$ respectively.

Dept. of Chemistry,
Ravenshaw College,
Cuttack, April 5, 1961.

BALARAM SAHOO.
D. PATNAIK.

I. Balaram Sahoo, Tripathy, B. and Patnaik, D.
To be published.

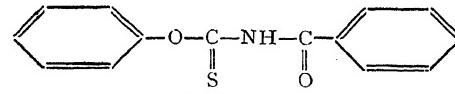
ACYL ISOTHIOCYANATES : FRIEDEL-CRAFT REACTION OF PHENOLS WITH BENZOYL ISOTHIOCYANATES

ISOTHIOCYANATES have been known to condense with phenols in presence of a Lewis acid. Thus Karrer and Weiss¹ studied the action of isothiocyanates and hydrogen chloride upon polyhydric phenols. They obtained in all cases substituted thioamides of the corresponding thioacids. For e.g., ethyl isothiocyanate with resorcinol gave ethylamide of thioresorcylic acid. And Kunz² studied action of isothiocyanates on phenols in presence of anhydrous aluminium chloride. They reported that phenyl isothiocyanate when condensed with phenol gave anilide of *p*-Hydroxybenzoic acid

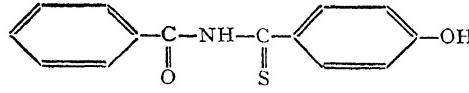
p-PhNHCSC₆H₄OH structure of which was also proved by these authors.

Acyl isothiocyanates have not apparently been studied. Benzoyl isothiocyanate was therefore selected for the present study, which was prepared according to Ambelang and Johnson.³ This was then condensed with phenol according to details described in the experimental. The product contains nitrogen and sulphur and was proved to be N-benzoyl-phenyl-thiocarbamate (I) and not the expected N-benzoyl-thioamide of *p*-Hydroxybenzoic acid (II) since the hydrolysis of the final product gave only benzoic acid and no trace of *p*-Hydroxythiobenzamide or *p*-Hydroxybenzamide or *p*-Hydroxythiobenzoic acid.

Resorcinol is found to behave analogously. Condensation of other polyhydric phenols is under investigation and a detailed paper will be presented in future. It can be concluded from results that acyl isothiocyanates behave differently from alkyl isothiocyanates and undergo addition reaction with phenols in presence of a Lewis acid. This is probably because there is a strong additional electromeric shift due to keto group in acyl isothiocyanates.



(I) (Found)



(II) (Expected)

EXPERIMENTAL

Condensation.—Phenol (4 g.) was mixed with finely pulverised anhydrous aluminium chloride (8 g.) and benzoyl isothiocyanate (6.6 g.) was added dropwise with efficient cooling. The reaction becomes vigorous and the colour of the mixture changes to red. It was left overnight at room temperature and decomposed with ice-water next day. The semi-solid red mass solidified when chilled in ice-bath. It was crystallised from ethanol and finally with petroleum ether (80°) when pale-yellow, orange needles were obtained. It melted at 66°C. Yield 2.5 g.

$\text{C}_{14}\text{H}_{11}\text{N} \cdot \text{SO}_2$ requires N, 5.83%; S, 12.45% (Found N, 5.61%; S, 12.40%).

The product was insoluble in alkali or dilute acid in cold. It did not give any colouration with alcoholic ferric chloride.

Hydrolysis.—Above product (1.0 g.) was refluxed with 10 ml. of 10% sodium hydroxide

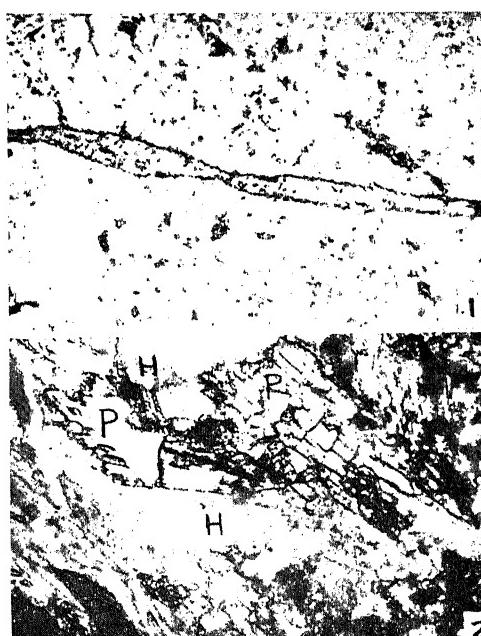
solution on a water-bath for three hours and finally on a wire-gauze for fifteen minutes. The red solution obtained after filtration was cooled and acidified with conc. hydrochloric acid when smell of hydrogen sulphide was detected and confirmed by lead acetate paper. The pale-yellow solid after crystallisation from petroether (using Norite for decolourisation) yielded colourless needles, m.p. 121°. Mixed melting point with authentic specimen of benzoic acid was undepressed.

Department of Chemistry,
St. Xavier's College,
Ahmedabad-9, April 27, 1961.
J. P. TRIVEDI.

1. Karrer and Weiss, *Helv. Chim. Acta*, 1929, **12**, 554.
2. Rivier and Kunz, *Ibid.*, 1932, **15**, 376.
3. Ambelang and Johnson, *J. Am. Chem. Soc.*, 1939, **61**, 632.

PISTACITE FROM THE GRANITES OF PUTALAPATTU, CHITTOOR DISTRICT, ANDHRA PRADESH

A STUDY of the granites of the Chittoor district undertaken by present author¹ has revealed the occurrence of pistacite in some of these rocks. The optical and chemical properties of pistacite occurring in the granites of Putalapattu (79° 6' 19": 13° 20' 38") are set forth in the present paper.



FIGS. 1-2. Fig. 1. A vein of pistacite in leucogranite, $\times 46$. Fig. 2. Pistacite in hornblende granite, $\times 50$. P = Pistacite. H = Hornblende.

The granites of the area are mainly hornblende granites with local variations. The hornblende granite becomes leucogranite with the impoverishment or complete absence of hornblende, and granodiorite with increase in the hornblende. These granites have been traversed by numerous joints, of which the East-West set is the most prominent one. These granites are intruded by dolerite dykes which show the same trend as that of the prominent joints. The minor joints and cracks are localised with pistacite at certain places.

The occurrence of pistacite in these granites is mainly of two types. One occurs as a vein in leucogranite (Fig. 1) and the other is in association with the hornblende in the hornblende granite (Fig. 2). It is observed from the study of granites that the hornblende is getting reduced as the pistacite is increasing. The grain size of pistacite occurring in the form of vein varies from 0.02 mm. to 0.3 mm., while the width of the vein varies from 0.06 mm. to 1 cm. The pistacite which occurs in association with hornblende is coarser than the former and varies in size from 0.2 mm. to 0.5 mm. The leucogranite consists of quartz, feldspars (potash and plagioclase) and pistacite, while quartz, feldspars (potash and plagioclase), hornblende, pistacite, chlorite and iron ore constitute the hornblende granite. The proportion of the various minerals is known from the modal composition (expressed in volume percentage) of the two rock types, which are given in Table I.

TABLE I
Modal Compositions

Constituents	Leucogranite	Hornblende granite
Quartz	54.14	31.75
Feldspars	39.75	46.11
Hornblende	..	9.27
Pistacite	6.11	6.63
Iron ore and chlorite	..	6.24

The pistacite from the two rocks is separated by using bromoform. By this method pure crop of pistacite was obtained from leucogranite whereas the heavy crop from the hornblende granite contained hornblende and chlorite besides pistacite. The green-coloured pistacite is later hand-picked from the heavy crop so as to obtain the pure product. The separated pure minerals are analysed for the iron and manganese contents. These two constituents have been reckoned as Fe_2O_3 and Mn_2O_3 . The optical properties of pistacites together with their Fe_2O_3 and Mn_2O_3 contents are given in Table II.

TABLE II

Optical and chemical properties of pistacite

Constants	Pistacite from leucogranite	Pistacite from hornblende granite
X	.. Yellow	Yellow
Y	.. Yellowish pink	Yellowish pink
Z	.. Bright yellow $X < Z < Y$	Bright yellow $X < Z < Y$
(-)2V	.. 72° to 76°	68° to 79°
$\gamma \wedge a$	.. 0.041	0.037 to 0.045
$X \wedge c$	.. 4°	4°
Fe_2O_3	.. 11.23	8.14
Mn_2O_3	.. 0.29	0.35

Table II reveals that there is a general agreement between the two minerals in their optical characters. Regarding their chemical characters, Fe_2O_3 is significantly higher than Mn_2O_3 in both the minerals, the mineral from leucogranite is richer in Fe_2O_3 than the other. The optical constants, $2V$, $\gamma \wedge a$ and $X \wedge c$ of the minerals when they are plotted in the Winchell's variation diagram² for epidotes show that the minerals are richer in $HCa_2Fe_3Si_3O_{13}$ molecules than $HCa_2Al_3Si_3O_{13}$ molecules, falling in the range of pistacites. The richness in Fe_2O_3 and the extreme paucity of Mn_2O_3 in these two minerals also confirm that they are pistacites.

It may be suggested that the pistacites are formed due to the hydrothermal alteration of plagioclase in the vein and the hornblende in the hornblende granite. This suggestion is evidenced by the vein development through minute cracks. According to Bateman³ the widening and thinning of the vein and non-matching walls in the vein (Fig. 1) are some of the criteria for the hydrothermal replacement.

Similar occurrences of epidote group of minerals were noticed by the author near Puttur ($79^\circ 34' : 13^\circ 25' 6''$) and by Chakrapani Naidu and the author near Bhakrapet ($79^\circ 10' 30'' : 13^\circ 41' 4''$). A detailed investigation on the occurrence of the epidotes in the granites of Chittoor district and their significance to the genesis of the granites is in progress.

The author expresses his deep sense of gratitude to Prof. M. G. Chakrapani Naidu, for his helpful suggestions and encouragement.

St. of Geology,
University College,
Mysore,
April 5, 1961.

M. S. MURTY.

Murty, M. S., *Indian Mineralogist*, 1961, 2(1), 71.
Winchell, A. N., *Elements of Optical Mineralogy*,
Part II, IV Ed., 1956, 449.
Bateman, A. M., *The Formation of Mineral Deposits*,
II Ed., 1956, p. 135.

A NEW PEPTIDE FROM BRAIN

During the course of our investigations on the Amino-acid pattern in the various areas of monkey-brain, we have observed a peptide band present in all the areas of brain. The peptide is characterised by its high R_f value, in the solvent system of Partridge¹ (Butanol: Acetic acid: Water 4:1:5, top layer), occupying the position farther than the farthest amino-acids, leucines, on the chromatograms. The unique position on the chromatograms and the subsequent amino-acid analyses have shown that it is different from the three peptides reported by Boulanger and Biserte² from brain tissues.

The peptide has been isolated as follows: Whole brain of monkey was homogenized in cold trichloroacetic acid, the protein-free extract extracted thrice with ether to remove acid. The extract is concentrated under reduced pressure. The concentrated extract is chromatographed on a cellulose powder column, elution being carried out by the same solvent system of Partridge. Since this peptide is the one having the highest R_f value in this solvent system, it comes out of the column in the first fractions itself. Fractions, 5 c.c. each, are collected, serially numbered and concentrated at room temperature, under a current of air. The individual fractions are again paper-chromatographed, and those which contain only the peptide (single peptide band) are pooled and analysed for its amino-acid content.

The sample is hydrolysed with 6N HCl at $110^\circ C.$ in a sealed tube for 18 hours, and the acid removed by repeated evaporation on a water-bath. The presence of tryptophan is tested on the unhydrolysed peptide sample, by means of the glyoxylic acid test, which is negative. Cystine and methionine were found to be absent in the hydrolysed peptide, by means of the platinic-iodide test. Pauly's reaction for imidazoles, on the chromatographed peptide hydrolysate, showed the presence of tyrosine, and the absence of histidine. The Sakaguchi reaction for arginine is positive. Proline and phenylalanine were confirmed by isatin spray.³ By a combination of the specific colour reactions and chromatography in different solvent systems,³⁻⁵ the following thirteen amino-acids have been found to be present in the hydrolysate of the peptide: α -Alanine, γ -Aminobutyric acid, Arginine, Aspartic acid, Glutamic acid, Glycine, Isoleucine, Lysine, Phenylalanine, Proline, Serine, Threonine and Tyrosine. Quantitative amino-acid analysis of the peptide hydrolysate, by the method of Giri *et al.*,⁴ using the two

solvent systems,³ gave the following molecular proportions of the amino-acids:

Isoleucine-6, Aspartic acid-5, Glutamic acid-5, Phenyl alanine-3, γ -Aminobutyric acid-3 α -Alanine-2, Glycine-2, Serine-1, Threonine-1, Lysine-1, Arginine-1, Proline-1 and Tyrosine-1.

We are grateful to the Indian Council of Medical Research for their generous grant for this research.

Dept. of Pharmacology T. JANARDANA SARMA,*
and Therapeutics, S. I. SINGH.
Lady Hardinge Medical C. L. MALHOTRA.
College, New Delhi,
May 25, 1961.

* Present address: Department of Physiology, S.N. Medical College, Agra.

1. Partridge, S. M., *Biochem. J.*, 1948, **42**, 238.
2. Boulanger, P. and Biserte, G., *Compt. rend. Acad. Sci. (Paris)*, 1951, **233**, 1498.
3. Oreskes, I. and Saifer, A., *Anal. Chem.*, 1955, **27**, 854.
4. Giri, K. V., Radhakrishnan, A. N. and Vaidyanathan, C. S., *Ibid.*, 1952, **24**, 1677.
5. McFarren, E. F., *Ibid.*, 1951, **23**, 168.

DISTRIBUTION OF UREASE WITHIN THE SEEDS OF CAJANUS INDICUS AND THE EFFECT OF MATURITY ON UREASE CONCENTRATION

NATH AND MUKHERJEE¹ stated that urease prepared from the seeds of *Cajanus indicus* was satisfactory for blood urea determination and that colour and turbidity changes after nesslerization were more delayed than after use of commercial urease preparation. It appeared of interest therefore to study the concentration of urease at different stages of maturity and in different parts of the seeds of *Cajanus indicus*. Seeds obtained from plants growing on similar soil in a small plot were used. Both the red and black varieties were taken for the study of the effect of maturity. Seeds of each variety were roughly classified into immature, mature and dry seeds and used simultaneously for urease determination. Only the mature seeds of the red variety were used for studying the distribution of urease. While dissecting individual seeds, the testa, the micropyle, the germ and the cotyledon were kept in petri dishes covered with moist filter-paper to prevent evaporation, and used without delay. Urease activity was determined by the method described by Damodaran and Sivaramakrishnan² on freshly prepared homogenates of approximately 1% concentration (on dry weight basis). The results obtained are given in Tables I and II.

TABLE I
Effect of maturity on urease content of seeds of *Cajanus indicus*

Variety	Maturity	Moisture %	Dry weight per 100 seeds (g.)	Mg. urea hydrolysed/hr./g. of dry material	Mg. urea hydrolysed/seed, hr.	Urease activity/seed %
Red ..	Immature	79.4	1.08	207	2.2	3.2
	Mature	63.0	4.93	805	39.7	58.3
	Dry	7.7	6.79	1003	68.1	100.0
Black ..	Immature	71.0	2.58	476	12.3	27.8
	Mature	61.7	5.39	577	31.1	67.5
	Dry	9.3	5.54	832	46.1	100.0

* Fresh seeds were used for determination of urease activity.

TABLE II
Distribution of urease in the different parts of the mature seeds of the red variety of *Cajanus indicus*

Part of seed	Moisture %	Mg. urea hydrolysed/hr./g. of dry material	Part present in 100 g. dry* seeds	Urease % of total activity in seed
Micropyle	54.9	49	2.77	0.1
Testa ..	63.9	69	12.69	0.8
Cotyledon	51.4	1311	82.92	96.8
Germ ..	35.7	1624	1.62	2.3

* Fresh seeds were used for determination of urease activity.

It would appear from results presented in Table I that the concentration of urease in the seeds was low in the immature seeds and maximum in the dry seeds. That this difference was less marked for the black variety can be explained on the basis of the relatively higher maturity of the immature black seeds. As a source for the preparation of the urease concentration, the dry seeds are therefore more suitable. The dry seeds of the red variety had a slightly greater concentration of the urease than those of the black variety.

From the results presented in Table II, it is clear that though urease activity on a unit weight basis is highest in the germ, the maximum concentration (96.8%) of the enzyme was in the cotyledon. The amount of urease in the micropyle, testa and germ together constituted only 3.2% of the total enzyme in the seed.

G.S.V.M. Medical College, P. P. SINGH.
Kanpur, April 22, 1961. B. K. SUR.

1. Nath, R. L. and Mukherjee, K. L., *Bull. Calcutta School Trop. Med.*, 1958, **6**, 12.
2. Damodaran, M. and Sivaramakrishnan, P. M., *Biochem. J.*, 1937, **31**, 1041.

PRESERVATION OF ALCOHOLIC SOLUTION OF FURFURAL AS A READY REAGENT FOR BAUDOUIN TEST

In performing the Baudouin test there is a necessity to use freshly distilled furfural. This limitation has often been levelled against the test as a criticism. Among the many methods suggested to prevent furfural from deterioration (which is due to auto-oxidation), one is the storage in an oxygen-free atmosphere.¹ The modification previously reported from this laboratory² is the storage of required amounts of 2% alcoholic solution of furfural for each test in small amber-coloured ampules. Thus preserved, we had observed that the alcoholic solution of furfural kept well indefinitely. This gave us the idea of studying the effect of storage in bulk a 2% alcoholic solution of furfural in stoppered amber-coloured bottles. Results of observations of the so preserved solution are recorded here.

TABLE I

Storage trials of 2% alcoholic solution of freshly distilled furfural at different temperatures for Baudouin test in amber-coloured glass-stoppered bottles

Sl. No.	Storage temperature	Liovibord Units (Red) in 1 cm. cell				
		0	1	2	3	4 weeks
I.	0-5° C. (Ice chest)	9.0	9.0	9.0	8.0	7.5
II.	25-28° C. (Room Temp.)	9.0	9.0	8.0	8.0	7.5
III.	37° C.	9.0	9.0	9.0	8.0	7.5
IV.	42° C.	9.0	9.0	8.0	7.5	7.0

The observations have been made by storing the alcoholic solution at different temperatures for 4 weeks. Since the solution has stood well as judged by its use for the Baudouin test for 4 weeks at 42° (Table I), it is considered that this is sufficient improvement as a method to be adopted, since it would save labour and time for the analyst from his having to distil furfural each day a test is to be performed.

The author's thanks are due to Dr. M. Srinivasan for many helpful suggestions and to Dr. V. Subrahmanyam, Director, for his kind interest.

C.F.T.R.I.,
Mysore, May 3, 1961.

O. P. KAPUR.

- Dunlop, A. P., Paul, R. Stoot and Samuel Swadesh, *Industr. Eng. Chem.*, 1946, 38, 705.
- Kapur, O. P., Srinivasan, M. and Subrahmanyam, V., *Res. and Industry*, 1959, 4, 105, 109-111.

LEAF PROTEINS IN NUTRITION

The possibility of using proteins isolated from various types of leaves as dietary supplements to improve the quality and raise the protein level of deficient diets was suggested by Pirie.^{1,2} The value of certain leaf proteins as supplements particularly in respect of their high lysine and valine contents has been well recognized by protein nutritionists. Systematic work on the isolation of leaf proteins both in laboratory and pilot plant scales from varied sources has been carried out by Pirie,³ Slade *et al.*⁴ and Guha *et al.*⁵ Sur and Subrahmanyam^{6,7} reported the supplementary value of lucerne leaf flour to the poor rice diets.

From the amino-acid composition of leaf proteins reported in literature⁸ it was seen that lysine contents of most of these proteins compared favourably with those of animal proteins. However, the methionine contents of the leaf proteins analysed have not been found to be high enough to prove of any supplementary value to the cereal and pulse proteins. But there had been stray cases of leaf proteins such as those from Spinach (*Spinacia oleracea*) whose methionine contents were found to be similar to those occurring in milk or egg. The object of the present investigation was to carry out a survey on the methionine contents of a number of leaf proteins including those which have not so far been analysed for this sulphur amino-acid.

Crude proteins were isolated by the simple method of extraction described by Pirie³ from the following leaves: Drumstick (*Moringa oleifera*), Methi (*Trigonella foenum-graecum*), Lettuce (*Brassica oleracea capitata*), Grass (*Hordeum vulgare*), Bengal gram (*Cicer arietinum*), Bamboo (*Bambusa arundinacea*), and Spinach (*Spinacia oleracea*). In all cases only fresh leaves were used. Moisture, protein, fibre and ash were determined by standard methods. Methionine was estimated using McCarthy and Sullivan's colorimetric method.⁹ The results are given in Table I.

The protein content of the crude extraction products varied widely depending upon the source. The highest value for protein obtained was for Methi while Bamboo contained the lowest amount of proteins. Except in the case of Methi the methionine content was more or less uniform in the proteins analysed. It is of interest to note that the values for this sulphur amino-acid obtained for Spinach, Bengal gram, Bamboo and a species of grass compared favourably with those reported in literature¹⁰ for whole egg (3.3%), milk (2.4%) and meat

TABLE I
Composition of certain crude leaf proteins

Protein source	% Moisture	% Protein (N × 6.25)	% Fibre	% Ash	Methionine (g per 16 g N)
Spinach (<i>Spinacia oleracea</i>)	4.3	47.9	1.7	2.3	2.7
Drumstick (<i>Moringa oleifera</i>)	5.3	49.2	1.9	1.6	2.2
Lettuce (<i>Brassica oleracea</i>)	4.2	57.2	2.9	3.1	2.3
Grass (<i>Hordeum vulgare</i>)	7.1	37.4	8.5	1.3	2.7
Methi (<i>Trigonella foenum-</i> <i>graecum</i>)	6.3	61.2	3.6	6.3	1.0
Bengal gram (<i>Cicer arietinum</i>)	4.7	60.6	1.9	5.3	2.6
Bamboo (<i>Bambusa arundinacea</i>)	8.1	19.3	1.0	4.3	2.5

(2.1%). This would indicate the added value of the leaf proteins tried in our experiments as supplements to the cereal and pulse proteins in Indian diets which are generally poor both in lysine and methionine.

The authors wish to thank Dr. H. P. Nath and the Director, Defence Science Laboratory, for their interest in this investigation.

SURINDER KAUR.
P. K. VIJAYARAGHAVAN.

Defence Science Laboratory,
Delhi, April 22, 1961.

1. Pirie, N. W., *Chem. and Ind.*, 1942, **45**, 61.
2. —, *Proc. Nut. Soc.*, 1956, **15**, 154.
3. —, *Food Manufacture*, 1957, **32** (9), 416.
4. Slade, R. E., Brauscombe, D. J. and McGowan, J. C., *Chem. and Ind.*, 1945, **25**, 194.
5. Guha, B. C. and Pal, P. R., *Sci. and Cult.*, 1953, **18**, 597.
6. Subrahmanyam, V. and Sur, B. K., *Ind. J. Med. Res.*, 1949, **37**, 319.
7. Sur, B. K. and Subrahmanyam, V., *Curr. Sci.*, 1954, **23**, 188.
8. Kuppuswamy, S., Srinivasan, M. and Subrahmanyam, V., *Proteins in Foods*, Indian Council of Medical Research, 1958, **23**, 230.
9. McCarthy, T. E. and Sullivan, M. X., *J. Biol. Chem.*, 1941, **141**, 871.
10. Block, R. and Weiss, K., *Amino Acid Handbook*, Charles C. Thomas, 1956, p. 341-43.

OVINE ABORTION DUE TO TOXOPLASMA GONDII IN INDIA

DURING the course of routine histopathological examination of tissues, spherical and aseptate pseudocyst-like structures resembling those of *Toxoplasma gondii* measuring about 45 microns in diameter were encountered in Giemsa-stained uterine section of an imported Australian Polwarth ewe that aborted and died at the Central Wool Research Station, Rishikesh, in Uttar Pradesh, India. The cysts gave rise to no inflammatory reaction in the surrounding tissues apparently due to a resistant cyst wall that prevented escape of antigenic and chemotactic substances.¹ The individual parasites within the pseudocyst were crescent or arc-shaped, with one end attenuated and the other more rounded measuring about 2 to 4 microns in width and 4 to 7 microns in length. The absence of nuclei and radial striations in the cyst-wall and lack of evidence of compartments differentiated the cysts from those of *Sarcocystis*² while their smaller size (45 to 50 microns) and absence of lobulation and septation distinguished them from those of *Besnoitia* and the 'M' organism.³ Unfortunately, no parasitological and serological study could be carried out to clinch the issue.

During the last 6 to 7 years, more than 2,500 serum samples from ewes that aborted were tested for evidence of agglutinins against *Brucella* with entirely negative results while aetiological studies failed to reveal any microbial factor other than a single isolation of *Listeria monocytogenes*⁴ in majority of the specimens examined so far.

Since the cause of abortion in at least 85 to 90% of cases remained undiagnosed, we undertook the present investigation to ascertain the possible role of *Toxoplasma gondii* which had already been found to possess abortifacient potential causing sporadic and enzootic illness in sheep elsewhere.⁴⁻⁷

As many as 50 sera samples taken from imported Polwarth ewes that recently experienced abortion at the Central Wool Research Station, Pashulok (Rishikesh), were examined by Sapin-Feldman dye test,⁸ complement-fixation,⁹ indirect haemagglutination,¹⁰ its antiglobulin¹¹ modification and gel-diffusion¹² procedures. All sera were inactivated at 60°C. for 20 minutes before testing. The results of serum antibody tests showed that as many as 40 (i.e., 80%) reacted at titres of 1:128 to 1:1,024 in the cytoplasm-modifying antibody technique. The values in the procedures were comparable in that all the above samples

exhibited a reaction zone higher than 1:32 in the latter four techniques. No other microbial pathogen was isolated on bacteriological examination of only ten samples that were cultured so far. It is interesting to report that about 20 to 30% of ewes that lambed normally also showed higher titres, indicating the important fact that maternal toxoplasmosis did not always kill foetus. A follow-up study of the healthy lambs of these ewes which had high antibody levels is being carried out and attempts are afoot to isolate *Toxoplasma gondii* by inoculation of brain and liver emulsion of foetuses into mice on the spot at the farm.

This is the first report in this country on the occurrence of the uterine form of toxoplasmosis in imported sheep from Australia where cases of toxoplasmosis had been described earlier, raising the important issue of the possibility of introduction of exotic diseases through importation of carrier animals. However, it is possible that toxoplasmosis may be prevalent in indigenous sheep in this country and only the results of further investigations on the subject can settle this issue.

P. G. PANDE.
R. R. SHUKLA.
P. C. SEKARIAH.
P. K. RAMACHANDRA IYER.

Indian Vet. Res. Institute,
Mukteswar (Kumaon),
January 17, 1961.

1. Frenkel, J. K., *Ann. N.Y. Acad. Sci.*, 1956, **64**, 215.
2. —, *6th Congr. Intern. Microbiol., Roma. Rias. Commun.*, 1953, **2**, 556.
3. Dhanda, M. R., Lal, J. M., Seth, R. N. and Sekariah, P. C., *Ind. Vet. J.*, 1959, **36**, 113.
4. Wickham, N. W. and Carne, H. R., *Aust. Vet. J.*, 1950, **26**, 1.
5. Cole, C. R., Sanger, V. L., Farrell, R. I. and Kornder, J. D., *North Amer. Vet.*, 1954, **35**, 265.
6. Hartley, W. J. and Marshall, S. C., *N.Z. Vet. J.*, 1957, **5**, 119.
7. Beverley, J. K. A. and Watson, W. A., *Nature, London*, 1959, **184**, 2041.
- Frenkel, J. K. and Jacobs, L., *A.M.A. Arch. Ophth.*, 1958, **59**, 260.
- Doney, M. K., Kimball, A. C. and Bauer, H. J., *Immunol.*, 1958, **81**, 177.
- Jobs, L. and Lunde, M. N., *J. Parasit.*, 1957, **43**, 308.
- Ide, P. G., Sekariah, P. C. and Ramachandran, P. K., *J. Infect. Dis.*, 1961 (In press).
- Shukla, R. R. and Sekariah, P. C., *Curr. Sci.*, **960**, **29**, 302.

MORPHOLOGY OF ONGE FOOT

The Onge are a small isolated community living in Little Andaman ($10^{\circ} 40'$ North Lat. and $92^{\circ} 30'$ East Long.) which is the southernmost island of the Andaman Archipelago situated in the Bay of Bengal. They are gradually diminishing in number, possibly as a result of prolonged inbreeding, and at present their total strength does not exceed 200 individuals. They live in dense tropical forest and walk barefooted many miles a day for hunting and collecting food. Physically they belong to the Negrito race who are more commonly known as Asiatic Pygmies.

This note is based on the material obtained from ten adult male Onges who came to Port Blair by canoes in September 1960. All of them were healthy and free from any deformity of foot. Contour tracings of their feet were carefully made according to the method described by Sarkar (1958). The morphological characters studied are the length (acropodium to pterion) and breadth (metatarsale tibiale to metatarsale fibulare) of foot, the length-breadth index of foot, hallux divergence angle and the relative lengths of hallux and second toe. The sample-size is admittedly too small to draw any valid conclusion.

The data are given in Table I along with the measurements of certain other aboriginal groups. It is apparent that in comparison with other tribes the absolute length of Onge foot is smallest and its absolute breadth exceeds only that of Vedda and Pahira feet. The values of length-breadth index shows that the Khasi have relatively broadest feet, the Onge occupy second position in this regard. The value of hallux divergence angle is maximum among the Onge which indicates that the deflection of hallux in Onge foot from the second toe as well as from the central axis of foot is greatest. In seven Onges the hallux was seen to be greater than the second toe in both feet (Minami's TT type), in three individuals the second toe was greater (Minami's FF type). No heterotype was found.

Schebesta (1952) has given the foot measurements of some Negritos of Malay Peninsula and Philippine Islands. His average figures for the Semang are : length 23.1 cm., breadth 10.2 cm., index 44.1, and for the Aeta : length 22.7 cm., breadth 10.0 cm., index 44.0. The Semang and Aeta feet thus appear to be broadest, broader even than that of Khasi, though they do not differ much from Onge foot in average length and breadth. It must, however, be mentioned here that Schebesta's measurements were obtained by direct method which yields results

TABLE I

Sr. No.	Tribe	No. of feet	Foot length (cm.)		Foot breadth (cm.)		Length Br. index		Hallux divergence angle		Author
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	
1	Onge	20	21.7-23.6	22.6	8.4-10.1	9.4	36.7-44.5	41.3	7°-11°	8.9°	Present study
2	Juang	86	21.2-26.8	24.2	8.6-11.8	9.6	36.1-45.1	39.7	4°-10°	5.9°	Sarkar
3	Oraon	88	22.5-28.0	26.0	8.4-11.7	10.1	36.0-44.2	39.8	4.5°-9°	6.7°	do.
4	Pahira	58	19.1-25.7	23.0	7.5-10.9	9.3	36.9-44.2	40.4	5.5°-10.5°	6.0°	do.
5	Mundari	90	22.7-27.4	25.1	8.8-11.5	10.0	32.4-44.0	40.0	4.5°-9.5°	6.3°	do.
6	Vedda	26	17.3-24.9	23.0	7.1-10.3	8.5	31.4-41.4	36.5	..	..	Osman Hill
7	Khasi	112	21.2-26.4	23.6	8.4-11.4	10.1	37.0-47.8	42.4	4.5°-9.5°	7.0°	Das and Uzir
8	Rabha	600	20.0-27.8	24.0	8.0-11.3	9.8	34.3-47.5	40.7	4.5°-10.0°	6.7°	do.

slightly different from that obtained by contour method.

Dept of Anthropology,
Indian Museum,
Calcutta-13, May 3, 1961.

P. GANGULY.
A. PAL.

1. Sarkar, S. S., *Proc. Nat. Ins. Sc.*, 1958, **24**, Part B (No. 4), 210.
2. Schebesta, Paul, *Die Negrito Asiens*, 1952, Band I, 6, 343.
3. Osman Hill, W. C., *Ceylon J. Sci. (G)*, 1941, **3**, 25.
4. Das, B. M. and Uzir, P., *Man in India*, 1961, **41** (1), 22.

SKELETO-MUSCULAR SYSTEM OF THE SUCKING PUMP OF *PAPILIO DEMOLIUS L.*

(LEPIDOPTERA : PAPILIONIDAE)

In course of his studies on the sucking pump of lepidopterous insects, the present writer came across two papers on the morphology of the head of *Papilio demolius* L. (Vasudeva, 1956; Srivastava, 1957). The two accounts were, however, found to differ considerably from each other in details. It was, therefore, considered desirable to attempt the problem again in order to arrive at a definite conclusion. Such a study proved very fruitful and resulted in the discovery of some interesting features. The present note deals with the extrinsic muscles of the sucking pump.

The cranial muscles of the sucking pump can conveniently be divided into three groups, viz., stomœdæal muscles, cibarial muscles, and labral muscles.

Stomœdæal Muscles.—These muscles consist of two pairs. Vasudeva (1956) shows a single "dilator of pharynx", originating on the "frons" and the "epistomal ridge" and inserting on the dorsal and posterior walls of the pump. Srivastava (1957) calls it "frontopharyngeal muscle" which, according to him, arises from the "inflected part of the frons".

First Stomœdæal Dilator (Fig. 1; 1).—This muscle arises on the inflected part of the frons (Fig. 1; IF) (which forms the uppermost part

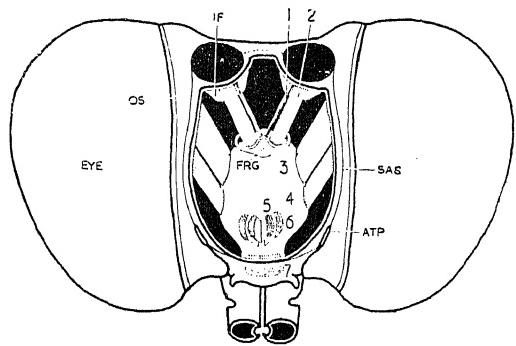


FIG. 1

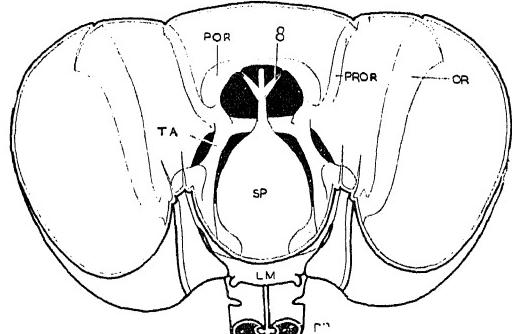


FIG. 2

FIGS. 1-2. Fig. 1. Anterior view of head with greater part of frontoclypeus cut away to expose the pump. OS, Ocular sulcus; SAS, Sub-antennal sulcus; ATP, Anterior tentorial pit; FRG, Frontal ganglion; 1, 2, 3, 4, 5, 6, 7, muscles described in text. Fig. 2. Inside view of head with greater part of the antero-dorsal area cut away obliquely. POR, Post-occipital ridge; PROR, Par-occipital ridge; OR, Ocular ridge; TA, Tentorial arm; SP, Sucking pump; LM, Labrum; PR, Proboscis; 8, Muscle described in text.

of the composite frontoclypeus), and is inserted on the dorsal wall of the pump behind the frontal ganglion (Fig. 1; FRG).

Second Stomœdaal Dilator (Fig. 1; 2).—This muscle is stouter than the first dilator. It arises lateral to the first dilator and is inserted likewise on the dorsal wall of the pump behind the frontal ganglion.

Cibarial Muscles.—These are divisible into two distinct groups, viz., a postero-lateral group and an antero-median group. Each of these groups consists of two pairs of muscles.

Vasudeva (1956) shows two contiguous pairs of muscles (Clypeal dilators in her text and Fig. 11; but "frontal dilators" in her Fig. 10), composing the postero-lateral group. Srivastava (1957), however, describes a single pair of "subantennal-buccal muscle" arising on the "oculo-antennal ridge".

The antero-median group, according to Vasudeva (1956), consists of a median mass of fibres which she labels as "dilator of buccal region". Srivastava (1956), however, describes a single pair of "posterior clypeocibarial muscle".

First Postero-Lateral Dilator of Cibarium (Fig. 1; 3).—This is the largest muscle of the pump. It arises partly from the dorsolateral part of the frontoclypeus (obviously belonging to clypeus) and partly from the ridge of the sub-antennal sulcus, and is inserted on the dorsal wall of the pump, anterior to the frontal ganglion.

Second Postero-Lateral Dilator of Cibarium (Fig. 1; 4).—This is a little less stout than the first postero-lateral dilator. It arises anterior to (3) and is likewise inserted on the pump.

First-Antero-Median Dilator of Cibarium (Fig. 1; 5).—This short muscle arises on the antero-median part of the frontoclypeus (obviously belonging to clypeus) and is inserted on the dorsal wall of the pump, anterior to the frontal ganglion.

Second Antero-Median Dilator of Cibarium (Fig. 1; 6).—This short muscle is slightly larger than the first antero-median dilator. It arises lateral to the first dilator and is likewise inserted on the dorsal wall of the pump.

Labral Muscles.—The labral muscles are composed of a single bundle of fibres. Vasudeva and Srivastava (1957) describe this as "clypeal dilator of mouth", and "anterior clypeal cibarial muscle" respectively. The latter seems to be based on interpreting clypeus as an area which actually belongs to the mouth.

'Compressor (Fig. 1; 7).—This unpaired muscle arises on the dorsal wall of the

labrum and is inserted on its ventral wall, near the latter's junction with the dorsal wall of the pump. Eastham and Eassa (1955) in *Pieris brassicæ* L. also label this muscle as labral compressor.

In addition to the muscles described above, the present writer has observed a paired muscle which arises on the dorso-lateral part of the post-occipital ridge (Fig. 2; POR), and is inserted on the posterior part of the stomœdæum just before the latter leaves the head. Both Vasudeva (1956) and Srivastava (1957) make no mention of this muscle in their respective papers. This is the first time such a muscle is being described in a lepidopterous insect. Alam (1951) in *Stenobracon deesæ* Cam. (Hymenoptera: Braconidae), describes a pair of more or less similarly oriented muscles (Occipital dilators of posterior pharynx). The present writer proposes to label the new muscle in *Papilio demolius* L. as the *Post-occipital dilator of stomœdæum* (Fig. 2; 8).

The author wishes to acknowledge his gratitude to his teacher Dr. S. M. Alam, and to Prof. M. B. Mirza, for providing all facilities. Aligarh Muslim University, MD. ZAKA-UR-RAB. Dept. of Zoology, Aligarh, U.P., March 6, 1961.

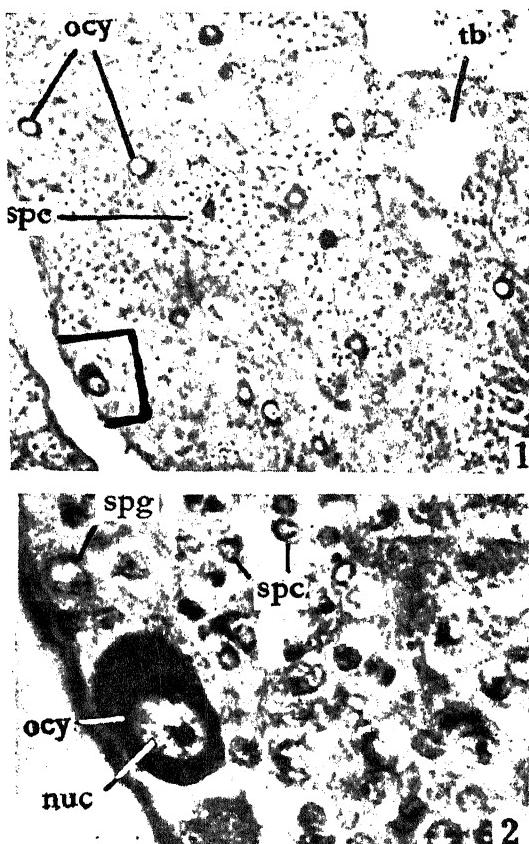
1. Alam, S. M., *Alig. Musl. Univ. Publ. (Zool. Ser. Ind. Ins. Typ.)*, 1951, **3** (1), 1.
2. DuPorte, E. M., *Proc. R. Ent. Soc.*, 1957, **31 A**, 109.
3. Eastham, L. E. S. and Eassa, Y. E. E., *Phil. Trans. Roy. Soc. Lond.*, 1955, **659 B** (234), 1.
4. Ehrlich, P.R., *Univ. Kansas Sci. Bull.*, 1958, **38** (2), 1315.
5. Schmitt, J. B., *Smith. Misc. Coll.*, 1938, **97** (4), 1.
6. Short, J. R. T., *Proc. R. Ent. Soc. Lond.*, 1951, **26 A**, 77.
7. Srivastava, K. P., *Curr. Sci.*, 1956, **25** (7), 226.
8. —, *Proc. Nat. Acad. Sci. India*, 1957, **27 B** (3), 113.
9. Vasudeva, S., *J. Zool. Soc. India*, 1956, **8** (2), 211.

AN INSTANCE OF HERMAPHRODITISM IN THE CATFISH *MYSTUS VITTATUS* (BLOCH)

OCCASIONAL hermaphroditism is recorded in several species of teleosts such as *Hilsa ilisha*,¹ *Huro salmoides*,² *Cirrhina reba*,⁴ *Rastreliger canagurta*,³ and *Barbus stigma*.⁵ It is evident from the available literature that the testicular and ovarian components of the hermaphrodite gonad vary greatly in their disposition and relation with each other.

The male specimen of *Mystus vittatus* reported here was collected from the river Ganges at Varanasi during March 1961. This species

exhibits sex dimorphism and the males can be easily identified by the presence of a distinct urinogenital papilla. The ovo-testis resembles a typical normal testis for external appearance. It is a paired narrow elongated structure, the outer margin of which is thrown into finger-like processes with attenuated tips. The testis was in the early prespawning phase, showing actively dividing germ cells. All stages of spermatogenesis could be made out, and some of the testicular tubules contained a number of spermatozoa also. Among the testicular substance Stage I oocytes are found scattered without any regular order (Fig. 1) and few are even intratubular. These oocytes readily take up Hæmatoxylin stain. The oocyte nucleus shows a prominent nucleolus (Fig. 2). The larger oocytes among them measure $27\text{ }\mu$ in diameter.



FIGS. 1-2. Fig. 1. Distribution of oocyte in the testis, $\times 180$. Fig. 2. A single oocyte enlarged—inset in Fig. 1, $\times 780$.

Technique—Bouin's fluid, Harris hæmatoxylin and Eosin.

Nuc, Nucleus. *Ocy*, oocyte. *Spg*, spermatogonium. *Spc*, spermatocyte. *tb*, testicular tubule

The authors are indebted to Dr. Ray-Chaudhuri, Professor of Zoology, Banaras Hindu University, for providing all facilities and encouragement.

THAKUR PRASAD SINGH

Department of Zoology, A. G. SATHYANESAN,
Banaras Hindu University,
Varanasi-5, May 13, 1961.

- Chacko, P. I. and Krishnamurthy, B., *Proc. 31st Indian Sci. Congress Abst.*, 1949, p. 167.
- James, F. M., *J. Morph.*, 1946, **79**, 93.
- Prabhu, M. S. and Antony Raja, B. T., *Curr. Sci.* 1959, **28**, 73.
- Sathyanesan, A. G. and Ranga Rajan, K., *Proc. 40th Indian Sci. Congress Abst.*, 1953, p. 208.
- , *Sci. Culture*, 1957, **23**, 203.

METACERCARIA OF *EUMEGACETES* SP. (TREMATODA : LECITHODENDRIIDAE)

IN DRAGON-FLY NAIADS FROM A STREAM AT WALTAIR

In the course of investigations on larval stages of trematodes from various freshwater organisms, dragon-fly naiads (Family: Libellulidae), from a slow-running stream at Waltair, were frequently found infected with encysted metacercariae. The cysts were mostly found in the hæmocœl in the posterior region of the body. The cyst wall is tough and thick. The size of the larva varies according to the stage of development. A well developed metacercaria (Fig. 1) as judged from the condition of the

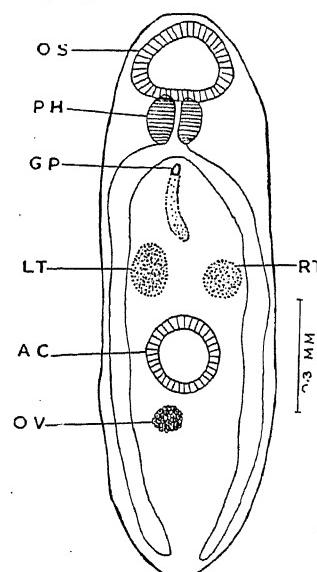


FIG. 1. Metacercaria of *Eumegacetus* sp.
AC, Acetabulum; *GP*, Genital pore; *LT*, Left testis; *OS*, Oral sucker; *OV*, Ovary; *PH*, Pharynx; *RT*, Right testis.

reproductive organs measures 1.55 mm. in length and 0.5 mm. in breadth. The body cuticle is smooth and without spines. The subterminal oral sucker (OS) measures 0.23 mm. \times 0.26 mm., being slightly larger than the acetabulum (AC) measuring 0.21 mm. in diameter and situated at a distance of 0.95 mm. from the anterior end. The conspicuous pharynx (PH) is 0.11 mm. \times 0.16 mm. and directly leads into the intestinal cæca reaching the posterior end. Reproductive organs consist of two testes which lie widely separated in the same plane slightly anterior to the acetabulum. The left testis (LT) is oval measuring 0.13 mm. \times 0.1 mm. while the right testis (RT) measures 0.1 mm. in diameter. The globular ovary (OV) situated immediately posterior to the acetabulum towards the left of the median line is 0.083 mm. in diameter. The genital pore (GP) is median, situated near the region of the intestinal bifurcation. These characters suggest that the larva belongs to the genus *Eumegacetus* Looss, 1900, of the family Lecithodendriidae.

It has been sufficiently documented that lecithodendriid trematodes require various aquatic arthropods such as Diptera, Odonata and Coleoptera as second intermediate hosts. Life-history studies of some lecithodendriids are also available. Stafford¹ experimentally raised adults of *Eumegacetus mediorimus* in chicken from metacercariae occurring in *Gomphus externus* and *G. plagiatus*. On the other hand, Hall² who encountered metacercariae of *Eumegacetus* sp. in various naiads taken from rivers at Indiana and Michigan could not succeed in obtaining the adults experimentally in chicken. Our knowledge of the adult species of the genus *Eumegacetus* which occur in various birds in India has been summarised recently by Jaiswal and Vasudev.³ However, there does not appear to be any information on their metacercarial stages; it was thus felt desirable to make a record.

One of us (R. M.) thanks the University Grants Commission for a scholarship. We are grateful to Professor P. N. Ganapati for facilities.

K. HANUMANTHA RAO.
R. MADHAVI.

Department of Zoology,
Andhra University,
Valtair, April 4, 1961.

Stafford, E. W., *J. Parasit.*, 1932, **18**, 131.

Hall, J. E., *Ibid.*, 1960, **46**, 309.

Jaiswal, G. P. and Vasudev, T., *Z. Parasitenk.*, 1960, **20**, 175.

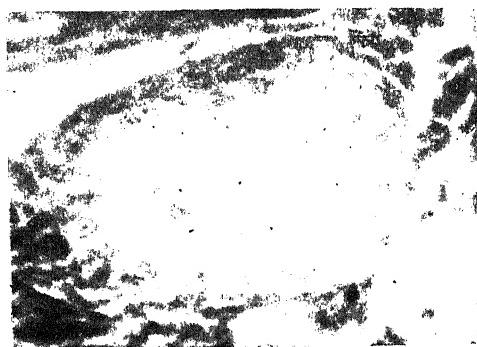
BIOVULAR FOLLICLE AND BINUCLEAR OOCYTE IN FIVE- BANDED SQUIRREL

The occurrence of an ovular and polyovular follicles and poly-nuclear oocytes in the ovaries of some of the mammals is well known.¹⁻¹⁵ But it has never been reported in the five banded squirrel (*Funambulus pennanti*), in which polynuclear oocytes are rare, whereas polyovular follicles, although common in embryonic or immature ovary, occur with less frequency in the adult.

Recently, in the left ovary of a squirrel with advanced extra-uterine pregnancy both the binuclear condition of an egg and also the presence of biovular condition of the follicle have been observed. This ovary shows follicular atresia and the presence of a number of primary oocytes. This condition has not yet been reported in the animal, although this is used in large numbers in a number of schools. This indicates that it must be of rare occurrence in these animals. Since noticing it in this female, we examined our earlier material but have failed to observe it even in pregnant females. Therefore, the occurrence of both these conditions, viz., biovular or polyovular follicle and binuclear ova in this abnormal female with an extra uterine pregnancy makes it of great interest.



FIG. 1. Biovular follicle, $\times 580$. Fixed in Bouin and sections at $6\text{-}\mu$ stained in Harris Haematoxylin and Eosin.

FIG. 2. Binuclear oocyte, $\times 509$.

In the biovular follicle both the oocytes lie in direct contact with each other (Fig. 1), are of equal size and are covered over by a common granulosa membrane. The binuclear oocyte is present in the same ovary. The nuclei appear exactly similar, both in shape and size, and are present in a single oocyte with uniform cytoplasm (Fig. 2). Although the material does not permit us to state with certainty as to the origin of polyovular and polynuclear ova, yet an examination of the sections of the ovary of this animal seems to favour the theory of the fusion of two or more adjacent uninuclear germ cells for the binuclear condition of an egg and concrescence of the adjacent follicles for the biovular condition.

Dept. of Zoology, GOPESH BHATNAGAR.
Banaras Hindu University, J. P. THAPLIYAL.
March 27, 1961.

1. Hartman, C. G., *Am. Jn. of Ant.*, 1926, **37**, 1.
2. Engle, E. T., *Anat. Rec.*, 1927 **a**, **35**, 341.
3. Mainland, D., *J. Anat. Lond.*, 1928, **62**, 139.
4. Evans, H. M. and Swezy, O., *Mem. Univ. Calif.* 1931, **9**, 119.
5. Ota, T., *Jap. J. Obstet. Gynec.*, 1934, **17**, 207.
6. Dederer, P. H., *Anat. Rec.*, 1934, **75**, 223.
7. Stockard, A. H., *Pep. Mich. Acad. Sci.*, 1937, **22**, 671.
8. Pankratz, D. S., *Anat. Rec.*, 1938, **71**, 211.
9. Lane, C. E., *Ibid.*, 1938, **71**, 243.
10. Waterman, A. J., *Amer. J. Anat.*, 1943, **72**, 473.
11. Harrison, R. J., *J. Anat. Rec.*, 1948 **a**, **82**, 21.
12. —, *Nature*, 1949 **b**, **164**, 409.
13. Davis, D. E. and Hall, O., *Anat. Rec.*, 1950, **107**, 187.
14. Dawson, A. B., *Ibid.*, 1951, **110**, 181.
15. Nakamma, Tsunenori, *Journ. Fac. Fish and Animal Husbandry*, Hiroshima University, 1957, **1** (3), 343.

A NOTE ON THE EFFECT OF FAST NEUTRONS ON THE SEXUALITY IN CASTOR

DRY seeds of HC. 1 castor were irradiated predominantly with fast neutrons in the atomic pile at the Apsara Atomic Reactor, Trombay (India), in 1959. The different doses of fast neutrons used were :—

Fast neutrons (integral flux)	Gamma contamination
$2.5 \times 10^{12} n/cm.^2/sec.$	$1.25 \times 10^4 r$
$5 \times 10^{12} n/cm.^2/sec.$	$2.5 \times 10^4 r$
$1 \times 10^{13} n/cm.^2/sec.$	$5 \times 10^4 r$
$5 \times 10^{13} n/cm.^2/sec.$	$2.5 \times 10^5 r$

HC. 1 castor is an improved variety much under use in Andhra Pradesh, India. The typical HC. 1 castor strain is characterised by having a few (about 30%) male flowers at the base and the rest female flowers above on the raceme.¹ With the object of exploring, beneficial mutations that could be used in plant breeding programmes, the study of the irradiated seeds of HC. 1 castor was undertaken in this department.

The behaviour of the M_1 seed was studied during 1959 and several morphogenetic and cytological effects of radiation were noticed (paper under publication). Regarding the effect on the sexuality observed in the M_1 population, only one plant from the treatment with $1 \times 10^{13} n/cm.^2/sec.$ showed a 100% pistillate raceme with one bisexual flower at the base. The progeny of this plant in the M_2 generation showed a general tendency for minimum number of male flowers and some in particular showed a few bisexual flowers on the primary raceme.

M_2 generation of the irradiated material was sown inflorescencewise in 1960 and the results regarding the variations in the sexuality proved very interesting. The progeny of the seeds treated with $2.5 \times 10^{12} n/cm.^2/sec.$, $5 \times 10^{12} n/cm.^2/sec.$ and $1 \times 10^{13} n/cm.^2/sec.$ have shown many plants with various gradations in the percentage of female flowers on the racemes, including a good number of 100% female ones as shown in Table I.

Such influence of neutron radiation on the sex ratio increasing the number of female flowers, has been observed in *Citrullus vulgaris* (Water melon), another monoecious plant.²

But, increase in the percentage of male flowers on the raceme including 100% male racemes, has also been observed in the M_2 generation of the neutron irradiated HC. 1 castor as shown in Table II.

TABLE I

Neutron dosages	Plants with 92-98% female flowers on the primary raceme	With 3 male flowers only in the primary raceme	With 2 male flower on the primary raceme	With 1 male flower on the primary raceme	100% female on the primary raceme only	100% female on the raceme 1st and 2nd order only	100% female on all spike	Total number of plants studied
$2.5 \times 10^{12} n/cm^2/\text{sec.}$..	59	2	2	8*	4	3	1271
$5 \times 10^{12} n/cm^2/\text{sec.}$..	63	2	1	1	2	Nil	795
$1 \times 10^{13} n/cm^2/\text{sec.}$..	62	7	6	4	5	Nil	521
Control	..	Nil	Nil	Nil	Nil	Nil	Nil	30

* In this group out of the 8 plants mentioned 4 were having a bisexual flower each, instead of a single male flower. † The six 100% female plants mentioned are all the progeny of a single parent.

The control plants on average had 3 racemes per plant and the pistillate plants on average, had 5.4 racemes per plant. The number of flowers per raceme vary according to the order of the raceme.

TABLE II

Neutron dosages	Plants showing 75-80% male flower on the racemes	80-90% male flowers on the racemes	90-95% male flower on the racemes	2 female flower only on the primary raceme	100% male on the primary raceme	Total No. of plants studied	
$2.5 \times 10^{12} n/cm^2/\text{sec.}$..	67	8	1	1	Nil	1271
$5 \times 10^{12} n/cm^2/\text{sec.}$..	13	2	2	1	Nil	795
$1 \times 10^{13} n/cm^2/\text{sec.}$..	8	3	Nil	Nil	1	521
Control	..	Nil	Nil	Nil	Nil	Nil	30

Most of these dominantly male plants and the 100% male plant come under 3 distinct parental groups.

How far these variations in the sexuality of HC. 1 castor induced by neutrons are genetic or non-genetic² is to be ascertained on further study. Meanwhile, the 100% female racemes are crossed with the typical HC. 1 strain and 100% male raceme as pollen parents to observe the behaviour in subsequent generations.

However, the 100% pistillate racemes induced by fast neutron radiation if they are not reversible, may prove very useful for the study of hybrid vigour and multiplication of hybrid castor seed on a commercial scale.⁴

The authors thank Dr. H. A. Razvi, Principal and Professor of Agricultural Botany, for his keen interest in the work and providing facilities.

Dept. of Agric. R. K. JAYA PRAKASH NARAIN.
Botany, B. V. RAMANA RAO.
College of Agric.,
Osmania University,
Hyderabad, A.P. (India), March 16, 1961.

- Kulkarni, L. G., *Castor*, Publication of Indian Central Oil-Seeds Committee, 1959.
- Thakare, R. G. and Bora, K. C., *Curr. Sci.*, 1960, 29, 322.
- Shiffris, O., *Genetics*, 1956, 41, 265.
- Zimmerman, L. H. and Parkey, W., *Agron. J.*, 1954, 46, 287.

BINUCLEATE POLLEN MOTHER CELLS IN *CLITORIA TERNATA*

An up-to-date list of the reports on the occurrence of sporadic binucleate pollen mother cells in 34 different plant materials since 1909 has been compiled by Kamra (1960). In normal and mutant barleys he showed that such occurrence is not as rare a phenomenon as is generally assumed, and about 2-4% of all P.M.C. studied were binucleate. Trinucleate and quadri-nucleate P.M.C. were also seen. The origin of binucleate condition was attributed to the failure of cell-wall formation at premeiotic mitosis.

Binucleate pollen mother cells were seen in *Clitoria ternata* at a very low frequency. They were mostly synchronized in meiotic division cycle, but one of the nucleus was always seen to be smaller than the other. Of the six binucleate cells observed so far in no one meiosis proceeded beyond early diakinesis stage. But degeneration of one of the nuclei of the binucleate cell as observed by Holden and Mota (1956) in *Avena* hybrid could not be seen in this plant.

Photomicrograph of one of the binucleate cell with both the nuclei at pachytene is given to add one more plant with sporadic binucleate P.M.C. The photomicrograph also shows that

the pachytene chromosomes of *Clitoria ternata* are well differentiated and some of them can be followed from end to end. The detailed



FIG. 1. A binucleate cell with both the nuclei at pachytene, one nucleus smaller than the other. All the eight differentiated pachytene bivalents can be seen. morphology of the pachytene chromosomes in the complement is being published elsewhere.

Applied Botany Section, NIRAD K. SEN.
Indian Institute of Technology, R. KRISHNAN.
Kharagpur, April 1, 1961.

- Holden, J. W. H. and Mota, M., "Non-synchronized meiosis in binucleate pollen mother cells of an *Arena* hybrid," *Heredity*, 1956, **10**, 109.
- Kamra, O. P., "Occurrence of binucleate and multinucleate pollen mother cells in *Hordeum*," *Hereditas*, 1960, **46**, 536.

SIMULTANEOUS OCCURRENCE OF *TILLETIA FOETIDA* (WALLR.) LIRO AND *ANGUILLULINA TRITICI* (S.) G. BEN. IN THE SAME EAR AND GRAINS OF WHEAT IN PAURI- GARHWAL, UTTAR PRADESH

THE simultaneous presence of the bunt and smut fungi in wheat heads has been observed by a number of workers. Maire¹ observed the simultaneous occurrence of *Anguillulina tritici* (S.) G. Ben (*Tylenchus tritici*) and *Tilletia caries* (DC) Tul. (*Tilletia tritici*) in wheat heads and Bedi et al.² recently reported the simultaneous occurrence of *Ustilago tritici* (Pers.) Rost. and *Anguillulina tritici* (S.) G. Ben. in a single ear of wheat.

An interesting observation was recently made in the rabi season of 1960 on an ear-cockle affected wheat field in Pauri-Garhwal in Uttar Pradesh. Normally ear-cockle of wheat caused by *Anguillulina tritici* thrives best on the plains

of Uttar Pradesh and its occurrence is uncommon in the hilly district of Pauri-Garhwal where true bunt caused by *Tilletia foetida* requiring a lower optimum temperature is more common. The association of these two widely different micro-organisms is both rare and interesting. It was observed that more than half of the ears of wheat were almost totally infected by the true bunt causing fungus, *Tilletia foetida*, whereas the top portions were affected by the ear-cockle disease bearing nematode galls visible between the glumes. Intermediary stages were also found where a nematode gall was filled with bunt spores or the bunt balls were infested with nematodes. Such an association of *Tilletia foetida* and *Anguillulina tritici* appears to be a new record for Uttar Pradesh and India.

Lab. of the Plant Pathologist R. S. MATHUR.
to the Government, M. P. MISRA.
Uttar Pradesh, Kanpur,
March 12, 1960.

- Maire, R., *Bul. de la Soc. Mycol. de France*, 1902, **18**, 130.
- Bedi, Kishan Singh, Jaswant Singh Chohan and Devinder Singh Chahal, *Indian Phytopath.*, 1959, **12**, (2), 187.

WILTING OF BIG RAIN TREES IN CALCUTTA

DEATH of well-grown Rain trees (*Enterolobium saman* Prain) has been noticed in various parts of Calcutta (Padmapukur roadside area, North Calcutta park, Calcutta Maidan, etc.) beginning from May 1959. In all, more than 32 trees were casualties. The trees were all big, 60-80 years old and were characterised by the barks of their main trunks being stripped bare of leaves but the trees themselves remained firmly rooted to the ground and they were so hard and rigid that they withstood uprooting by a strong evening gale (90 m.p.h.) last May.

We prepared by standard methods pure cultures of *Fusarium* species from roots of the affected trees supplied by courtesy of Mr. P. C. Muzumdar, Commissioner of the Calcutta Corporation. Two subcultures in potato dextrose agar media sent by air were kindly identified by Dr. W. L. Gordon, Plant Pathologist, Manitoba, Canada, as *Fusarium solani* sensu Snyder and Hansen.

Fusarium solani has been reported from tropical soils affecting shisham (*Dalbergia sissoo* Roxb.), guava (*Psidium guava*, L.), etc., and ultimately killing them while Das Gupta recorded variations in the number of *Fusarium* colonies with the season.

Pathogenicity tests on 3-month old seedlings from trees carried out by us showed that 5 out of 11 seedlings infected by us died about 1½ months after infection. We re-isolated *F. solani* from the roots of the dead seedlings. Section of the affected roots showed brown colour in the xylem area and the presence of hyphae. Inoculation of roots of about one year plants were unsuccessful.

It would appear that the ultimate wilting and death of these trees is due to root infection by *F. solani* though the upper parts of dead shoots may harbour other fungi. We had no opportunity of tracing the earlier stages of the disease due to lack of material.

According to Garret,² death is due to the blocking of xylem vessels—not so much by mycelium as by a gum-like toxin, thermostable and dialysable. Such a secretion would also account for the rigidity of the trunk of the dead tree.

Verma³ considers that trees beyond a certain age exhibit decreasing resistance to infection, thus explaining casualties from the same age-group. For control of the disease, Bakshi⁴ suggests intermittent flooding of the soil while Chauhan⁵ recommends treatment of the soil with finely ground mustard oil-cake powder.

We suggest both methods be tried for control of *Fusarium* wilt.

Dept. of Medical Mycology, S. R. BOSE.
School of Tropical Medicine, S. K. SEN GUPTA.
Medicine, Calcutta and State Agri. Res. Inst., Calcutta, March 7, 1961.

1. Das Gupta, S. N., *Curr. Sci.*, 1947, **16**, 256.
2. Garret, S. D., *Biology of Root-infecting Fungi*, Cambridge University Press, 1956.
3. Verma, G. S. *J. Indian bot. Soc.*, 1951, **30**, 14.
4. Bakshi, B. K., *Ind. For. Rec.*, Mycology Series, 1957, **2**, 1.
5. Chauhan, S. K., *Proc. 47th Ind. Sci. Congress (Bombay)*, Part III, 1960, p. 329.

OCCURRENCE OF INTRACORTICAL ROOTS IN BAMBUA

THE roots of *Bambusa arundinacea* are typically polyarch and usually show numerous air-spaces in the middle cortex. A new feature of these roots noticed by us is the occurrence of intracortical root branches which instead of coming out at right angles from the parent root travel vertically downwards through some of the air-spaces in its cortex (see Fig. 1). In some sections, some of these intracortical roots are seen to give rise to lateral branches while they are still enclosed in the cortex of the parent root

and these branches too travel vertically downwards through the cortex of the first root. The thinner branches show root hairs spreading out in the cortical air-spaces. The structure of the intracortical roots is like that of the ordinary roots of this plant.

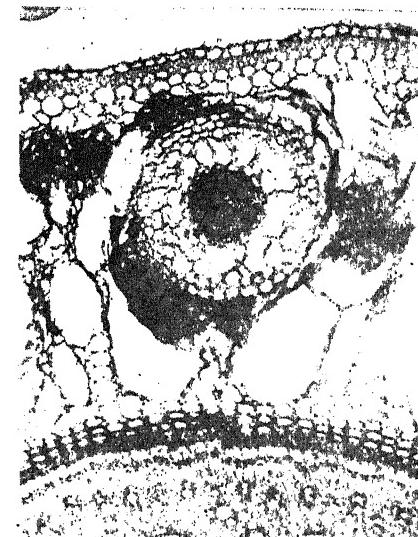


FIG. 1. Root of *Bambusa arundinacea* showing intracortical root and its branches (dark patches), $\times 102$.

The occurrence of intracortical roots in *Bambusa arundinacea* is being reported here for the first time although they occur in some other monocotyledonous plants, e.g., some Bromeliaceae¹ and *Asphodelus tenuifolius*.² Detailed work on the origin and course of these roots is in progress and will be published later.

We are thankful to Messrs. K. N. Singh and D. Banerji for giving us some sections of these roots.

Botany Department, D. DARSHAN PANT.
The University, BHARATI MEHRA.
Allahabad, May 3, 1961.

1. Solereder, H. and Meyer, F. J., *Systematische Anatomie der Monokotyledonen*, 1928, **4**, 123.
2. Pant, D. D., *J. Indian bot. Soc.*, 1943, **22**, 1.

TWO FERN RUSTS FROM INDIA

RECORDS of rusts on ferns are rare in India. Lately as a result of study of some fern rust collections, one new species of *Uredinopsis* and a new host record for *Hyalopsora polypodii* (Diet.) Magnus have come to light, the account of which is given in this paper. The specimens have been deposited in the Herbarium *cryptogamiae indicae orientalis*, New Delhi, and indicated by H.C.I.O. numbers in the text.

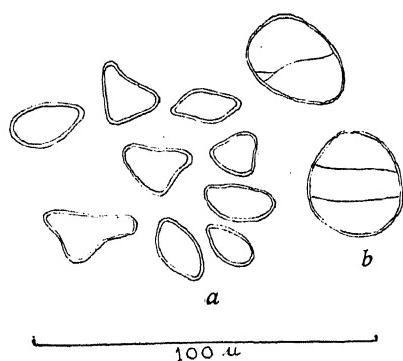


FIG. 1. *Uredinopsis syngammes.*
a, Uredospores; b, Teliospores.

1. *Uredinopsis syngammes* spec. nov. (FIG. 1)

Uredia hypophylla, subepidermalia, dispersa in maculas discoloras ambitus indefiniti, ut plurimum lineares limitatas nervis, rotundas, 0.4-0.9 mm. diameter, luteolas, postea evadentes brunneas vel etiam alutaceas. Peridium convexum, incolorum, tenue; cellulæ peridiales isodiametricæ vel irregulariter polygonales, 9-11 x 12-13 (14) μ , parietibus usque ad 1.5 μ crassis; uredosporæ hyalinæ, brevissime pedicellatæ, sorum totum implentes, cordiformia vel femuriformia, nonnullæ ellipticæ vel subcylindricæ, symmetricæ vel asymmetricæ 16-28 x 10-20 μ , ut plurimum 19-23 x 11-18 μ ; sporarum parietes incolori, leves, usque ad 2 μ crassi. Telia diffusa, amphigena, ut plurimum hypophylla, in maculis purpurascensibus fusce brunneis irregularibus linearibus; teliospore subepidermales, intercellulares, dispersæ sed ut plurimum laxè aggregatae in seriem unam, incoloræ vel pallide luteolæ, subsphæroideæ vel ellipsoideæ, 2-5-cellulatæ, raro unicellularæ, 35-42 x 28-30 μ , parietibus levibus, 1-1.5 μ crassis.

In foliis viventibus *Syngramme fraxinea* Bedd. [*Coniogramme affinis* (Wall.) Hieron] ad Narkanda, 2,300 m. supra mare altit. 17 Octobris 1958 D.P. Mishra. Typus.

Uredia hypophyllous, subepidermal, pustular, scattered on discoloured spots of indefinite extent which are usually linear and delimited by veins, round, 0.4-0.9 mm. in diameter, yellowish, later brownish or even light tan-coloured; peridium convex, colourless and delicate; peridial cells isodiametrically to irregularly polygonal, 9-11 x 12-13 (14) μ with walls up to 1.5 μ thick; uredospores hyaline, very short stalked, filling completely the sorus, heart to femur head-like, some elliptic to subcylindric, symmetrical to

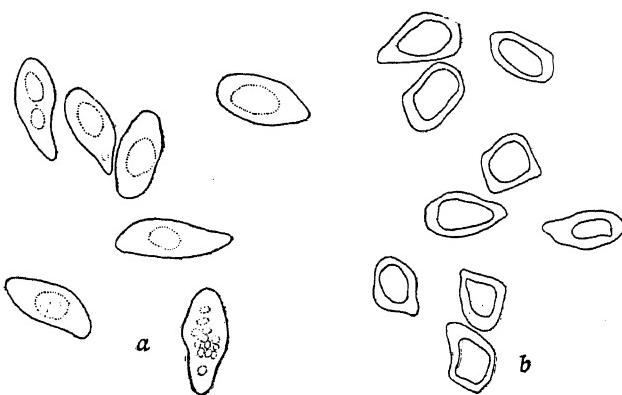


FIG. 2. *Hyalopsora polypodii.* a, Uredospores, $\times 405$; b, Amphispores, $\times 330$.

asymmetrical, 16-28 x 10-20 μ (mostly 19-23 x 11-18 μ) ; spore walls colourless, smooth, up to 2 μ thick; telia diffuse, amphigenous but hypophyllous on brownish to purplish dark brown-coloured irregular linear spots; teliospores subepidermal, intercellular, scattered but mostly loosely aggregated in a single layer, colourless to light-yellow, subsphæroid to ellipsoid, 2-5-celled, rarely one-celled, 35-42 x 28-30 μ , wall thin, about 1-1.5 μ thick.

On leaves of *Syngramme fraxinea* Bedd. = *Coniogramme affinis* (Wall.) Hieron. Narakanda (9,000 ft. above sea-level). 17-10-1958, D. P. Mishra (H.C.I.O. No. 26832) Type; 12-11-1959, M. M. Payak (H.C.I.O. No. 26831).

Hiratsuka (Bot. Mag. Tokyo, 1934, 48, 45) described *Milesina coniogrammes* on *Coniogrammes intermedia* from Japan. So far, as we are aware, this appears to be the only record of rust on this fern genus. Through the kind courtesy of Dr. N. Hiratsuka we were able to examine three collections (Y. Yoshida, 1932; N. Hiratsuka, 1938 and 1939) which revealed that it is quite distinct from the species described above in shape as well as size of the uredospores. In *M. coniogrammes*, uredospores are obovate to fusiform and measure 24-45 x 15-22 μ whereas in our specimen they are heart-shaped to femur-head-like. We were not able to locate any teliospores on the specimens from Japan.

2. *Hyalopsora polypodii* (Diet.) Magnus (Fig. 2) in Ber. Deutsch. Bot. Ges., 1901, 19, 582 (Fig. 2)

This rust produces almost rounded, orange-yellow-coloured pustular uredia scattered or sometimes aggregated on both the leaf surfaces and measure up to 0.5 mm. in diameter. Uredospores are mostly ellipsoidal or oblong 20-35 x 12-16 μ in size; episporule is thin, hyaline and smooth. There are 4 germ pores which are

arranged equatorially; spore contents are orange-yellow. Amphispores are also present which are much variable in shape, subglobose, ovate or polygonal due to mutual pressure and are $20-35 \times 16-20 \mu$ in size; episporule is rather thick, almost smooth measuring $2-6 \mu$. Telia were not seen.

On leaves of *Diplazium japonicum* (Thbg.) Bedd., Darjeeling, 20-11-1959, S. P. Raychaudhuri (H.C.I.O. No. 26846).

Hyalopsora diplazioides Hiratsuka (*Jour. Jap. Bot.*, 1940, 16, 613), recorded on this host genus from Japan is quite different from this species in having much larger uredospores ($23-41 \times 15-23 \mu$) with conspicuous verruculose episporule.

Sincere thanks are due to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology, for his keen interest and encouragement; also to Prof. N. Hiratsuka of Japan for confirming identity of new species. We are indebted to Dr. B. L. Chona, Mycologist, for his valuable guidance; to Dr. H. Santapau, Head of the Biological Department, St. Xavier's College, for rendering the Latin diagnosis of new species and to Dr. P. N. Mehra, Head of the Botany Department, Punjab University, for identification of fern host (*Diplazium japonicum*).

Division of Mycology and
Plant Pathology,
Indian Agric. Res. Inst.,
New Delhi-12.

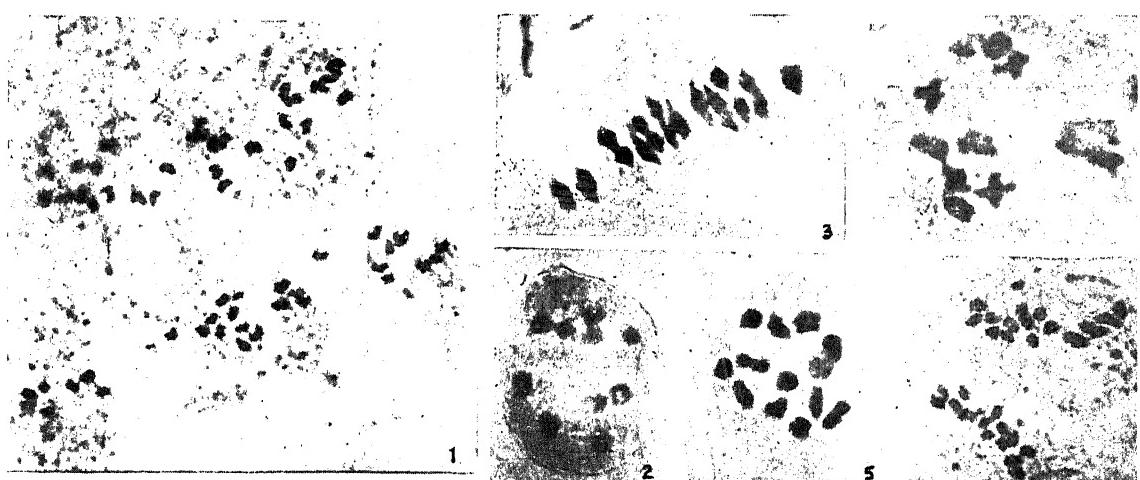
R. L. MUNJAL.
J. N. KAPOOR.

CYTOTOLOGICAL OBSERVATIONS ON THE INDIAN SPECIES OF COMMELINACEAE

THE family Commelinaceæ has a wide range distribution, and about 70 species comprising 9 genera are known to grow wild in different parts of India. In view of the wide range variations and also of the occurrence of closely similar intermediate forms, the classification and delineation of species by earlier workers¹⁻³ need revision. A detailed revision of the Indian species of the family supplemented by anatomical and cytological data is at present being carried out.^{9,10}

In this report chromosome numbers of species (excluding one variety) comprising 3 genera have been recorded, following the normal aceto-carmine squash technique. Herbarium specimens of all the species collected are available in the Western Circle of the Botanical Survey of India, Poona.

All the 5 species of *Commelina* Linn. examined have a regular meiosis, and revealed numbers in a multiple series of $x = 15$. Meiotic studies have been made on *Commelina subulata* ($n = 30$) and *C. hasskarlii* ($n = 45$) for the first time. *C. subulata* which has not been so far collected from the Western Ghats has now been recorded from several localities between Dhawad and Khed (Poona District). In one plant *C. paludosa* collected from Poona, 60 clear bivalents were counted at metaphase I, thus confirming the existence of polyploid races in the different ecotypes of this species.



FIGS. 1-6. Fig. 1. *Murdannia simplex* ($n=30$, A I). Fig. 2. *M. semiteres* ($n=10$, M I). Fig. 3. *Cyanotis fasciculata* ($n=12$, M I). Fig. 4. *C. cucullata* ($n=10$, late diakinesis). Fig. 5. *C. tuberosa* var. *ascendens* ($n=12$, M I). Fig. 6. *Commelina diffusa* ($n=15$, A I). (Magnification, $\times 1,800$).

TABLE I
Results on the various species of Commelinaceæ investigated

Sl. No.	Name of species	Locality	Present observations	Previous observations
1	<i>Commelina forskaalii</i> Vahl	.. Mukteshwar (Maharashtra), 65805; Poona, 64542 and 64560	$n=15$	$2n=28^8, 30^7$
2	<i>C. diffusa</i> Burm. f. <i>(=C. nudiflora</i> auct. non Linn.)	Agumbe (Mysore), 68088	$n=15$	$2n=28^{6,8}, 30^{4,5}, 56^{4,6}$
3†	<i>C. paludosa</i> Bl. <i>(=C. obliqua</i> Ham. ex Don)	Poona, 64939	$n=60$	$2n=45, 60^6, 2n=100, 150^{5,6}$
4*	<i>C. hasskarlii</i> Cl.	Poona, 65948	$n=45$	..
5*	<i>C. subulata</i> Roth	.. Gargatwadi, Khed Taluk (Maharashtra), 66273	$n=30$	..
6	<i>Cyanotis axillaris</i> (Linn.) R. & S.	Poona, 64715; Agumbe (Mysore), 67828 and 67879	$n=10$	$2n=20^{4,5,7}$
7*	<i>C. cucullata</i> Kunth	Ghavar (Maharashtra) 68547	$n=10$	..
8	<i>C. cristata</i> (Linn.) D. Don	.. Poona, 64715; Agumbe (Mysore),	$n=12$	$2n=24^{4,5,7}$
9*	<i>C. fasciculata</i> R. & S.	Poona, 64265 64589 and 64639	$n=12$	..
10*	<i>C. tuberosa</i> R. & S.	.. Mahabaleshwar, 67711	$n=36$	..
11*	<i>C. tuberosa</i> R. & S. var. <i>adscendens</i> Cl.	Poona, 64528 do. 64564	$n=12$ $n=24$	..
12*	<i>Murdannia pauciflora</i> (Wt.) Brück. <i>(=Aneilema pauciflorum</i> Wt.)	Agumbe (Mysore), 67851	$n=10$	..
13†	<i>M. simplex</i> (Vahl) Brenan <i>(=A. sinicum</i> Ker-Gawl. incl. Lindl.)	do. 67527	$n=30$	$n=20$ and $2n=40^7$
14†	<i>M. spirata</i> (Linn.) Brück. <i>(=A. spiratum</i> R.Br.)	do. 68018	$n=9$	$2n=20^6, 40^4$
15*	<i>M. ochracea</i> (Dalz.) Brück. <i>(=A. ochraceum</i> Dalz.)	do. 68025	$n=18$ $n=30$	..
16*	<i>M. semiteres</i> (Dalz.) Santapau <i>(=A. paniculatum</i> Wall.)	Mahabaleshwar, 67575 Agumbe (Mysore), 67837 Bhimashankar (Maharashtra), 66247 Matheran (Maharashtra), 64355	$n=7$ $n=10$ $n=20$	..

* Chromosome numbers recorded for the first time. † Haploid numbers differing from previous observations.

It is interesting to observe that both *Cyanotis axillaris* and *C. cucullata*, whose taxonomic position needs further scrutiny, have a diploid complement of $2n=20$ only, whereas all the other Indian species of *Cyanotis*, investigated so far, have a basic number of $x=12^{4-7}$. The highest number recorded so far in this genus is $n=36$ for *C. tuberosa*.

The present study on the genus *Murdannia* Royle has shown the existence of polyploid and aneuploid types in the various geographical races of the same species. The various species of *Aneilema* R. Br. and *Murdannia* are being studied in detail, to understand the affinity between these two genera, and to observe how far Brückner's² splitting up of the genus *Aneilema* is justified by cytological and other evidences.

Results of the observations are recorded in Table I.

Western Circle,
Bot. Survey of India,
Poona-1, April 4, 1961.

R. S. RAGHAVAN.
SESHAGIRI RAO ROLLA.

- Clarke, C. B., *D. C. Monogr. Phan.*, 1881, 3.
- Brückner, G., *Engl. Bot. Jahrb.*, 1927, 61, Beibl., 137.
- Brenan, J. P. M., *Kew Bull.*, 1952, 179.
- Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, George Allen & Unwin Co. Ltd., 1955, 339.
- Sharma, A. K., *Genetica*, 1955, 27, 323.
- and Archanna Sharma, *Jour. Genet.*, 1958, 56, 1.
- Shetty, B. V. and Subramanyam, K., *Proc. Ind. Sci. Cong.*, 1961, Abs., p. 299.
- Morton, J. K., *Jour. Linn. Soc. Lond.*, 1956, 55, 507.
- Seshagiri Rao Rolla, *Proc. Ind. Sci. Cong.*, 1958, 331.
- et al., *Ibid.*, 1960, 366.

**GIBBERELLIN INDUCED
PARTHENOCARPY IN GUAVA
(*PSIDIUM GUAJAVA* L.)**

BALASUBRAMANYAM AND RANGASWAMI¹ recently reported parthenocarpy in guava induced by 'pollen hormone'. Gibberellin is a well-known agent for producing parthenocarpic fruits, and in this note are reported some interesting results obtained by inducing parthenocarpy in guava by a potassium salt of gibberellic acid. This salt, referred to as GA in what follows, was supplied by the British Drug House, Bombay. The experiments were conducted on three-year old guava plants of the Allahabad Safeda variety. Unopen flowering buds were emasculated on the 23rd August 1960 and the following day aqueous solutions of GA in concentrations of 100, 500, 1,000 and 10,000 p.p.m. were mixed with lanolin paste and applied uniformly to 4 lots of 15 buds each. An equal number of control buds were allowed to grow normally or were treated with GA free lanolin.

Observations were taken at weekly intervals. Within 10 days of the experiment, control buds and buds treated with GA in concentrations of 100 and 500 p.p.m. dropped off without fruit formation. Small parthenocarpic fruitlets were formed in buds treated with 1,000 p.p.m. GA but these too dropped off within a month. When the fruitlets were cut open, a few brown shrivelled ovules were found.

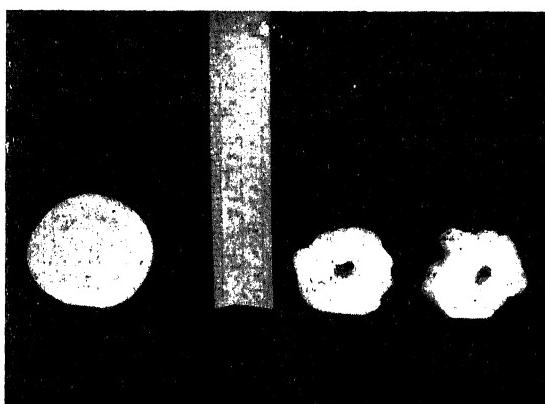


FIG. 1. Transverse sections of two parthenocarpic and one normal fruits of the Allahabad Safeda variety of guava.

Treatment of buds with GA, 10,000 p.p.m., gave the best results. Out of the 15 treated buds, 5 fruitlets grew to a size of 1.25 cm. diameter whereas the rest of the 10 buds produced parthenocarpic fruits which reached maturity 15 days earlier than the normal crop. The fruits

were oblong with swollen calyx and ridges on the surface (Fig. 1). The fruit pulp was more granular than the pulp of the normal fruits. It was strawen in colour and had an ascorbic content of 726.7 mg. against 354 mg. per 100 gm. pulp of the normal fruits.

Govt. Fruit Research Station, S. S. TEAOTIA,
Basti, Uttar Pradesh, I. C. PANDEY.
April 11, 1961. R. S. MATHUR.

1. Balasubramaniyam, V. R. and Rangaswamy, G., *Curr. Sci.*, 1960, 28, 413.

**A NEW SPECIES OF HAPLOSPORELLA
FROM MAHARASHTRA**

In the course of her mycological collections, the writer encountered a member of the phaeosporous Sphaeropsidales on several bushes of *Nerium odoratum* Soland. growing on dead leaves in the campus of the Law College, Poona. The fungus was identified as a species of *Haplosporella*, sensu Petrak and Sydow (1926-27). As the fungus is not previously reported on this host it is presented here as a new species as follows:

Haplosporella neriicola SPEC. NOV. KALANI

Infectionis maculae epiphyllae, circulares, verucosae, elevatae, dispersae, nigrae; stromata separata, verrucae, similia, fortiter evolute supra, immersa, postea evadentia erumpentia, fusca, carbonacea, globosa vel pulvinata, 209-570 × 228-760 μ . Pycnidia aggregata, 3-7 in singulis stromatibus, immersa in cateryas botryosas, nigra, obtuse papillata, singula 76-190 × 38-380 μ . Conidiophori, simplices, breves, continui hyalini, laxe dispositi, 4-2 μ longi; conidia ovoidea vel oblonga, alte brunnea, orassis parietibus praedita, l-cellularia, insidentia singula 17 = 8.5 μ . Hyphae steriles plures.

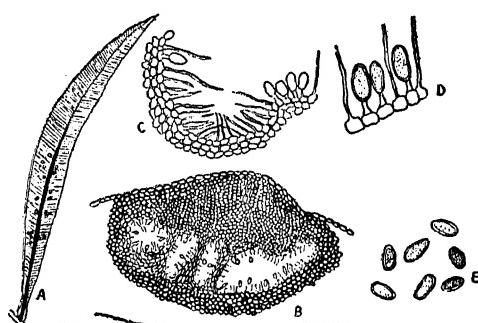


FIG. 1. A, Habit × natural size; B, Section through stroma, × 30; C, Section through pycnidium, × 132; D, Conidiophores, conidia and sterile threads, × 20; E, Conidia, × 132.

Typus lectus in foliis emortuis Nerii odorum Soland. a I. K. Kalani ad Poona, in India mense novembri anni 1960.

The type is deposited at the Herbarium Cryptogamie, New Delhi, India and Kew, England.

This is the ninth record for *Haplosporella* from India.

The author is grateful to Prof. M. N. Kamat for his guidance and deep interest and to the Director of the M.A.C.S. for facilities given at the Institute. Grateful thanks are also due to Prof. H. Santapau for the Latin diagnosis.

M.A.C.S., (MISS) I. K. KALANI.
Poona-4, April 21, 1961.

1. Agnihothrudu, V. and William Hadfield, "A new species of *Haplosporella* from Assam," *Jour. Indian bot. Soc.*, 1959, **38** (4), 546.
2. Petrak, F. and Sydow, H., *Report nov. Spec. Regn. Veg. Brzheste*, 1926-27, **42**, 1.

THE COMPOSITIONS AND THE ADAPTATION MODIFICATIONS OF POLISH LOESS MOSS FLORA

STUDIES regarding the composition, growth and the adaptation modifications of the moss flora specific to the loess area of the South-Eastern Poland were carried out during the years 1959-61. The loess land has a characteristic set of conditions for the growth of sporophyta and vascular plants. Although these conditions have a close resemblance to those found in the steppes, they exert much more influence upon the compositions and individual adaptation of the moss species growing on the loess lands than they do in the steppes (Gams, 1932 and Karczmarz, 1960, and 1961). The reasons underlying it are the high calcium carbonate contents (19.0%), and the amount of rainfall received by these areas in the spring and the summer. A few of the species growing in these areas are so-called calcifilous species, like *Aloina brevirostris*, *A. rigida*, *Barbula convoluta*, *B. cylindrica*, *B. fallax* (in the majority of cases var. *brevifolia*), *B. hornschuchiana*, *B. lurida* spp. *cordata*, *Barbula rigidula*, *Phascum curvicollum*, *Pottia bryoides*, *P. intermedia*, *P. lanceolata*, etc., a majority of which shows a special type of body

structure and behaviour as a means of adaptation to the dry conditions found in loess areas, (i.e., Bryoxerogeophytia and Ephemerophytia). The first group, i.e., Bryoxerogeophytia, besides including a few acrocarpous moss species, like the species belonging to the genus *Acaulon*, *Aloina*, *Barbula*, *Pottia*, etc., also includes pleurocarpous species like *Brachythecium albicans*, *B. glareosum*, *Camptothecium lutescens*, *Campylium chrysophyllum* var. *Sommerfeltii*, *Thuidium abietinum* and *Th. recognitum*. The second group, i.e., Ephemerophytia, on the other hand, is formed by the acrocarpous species, like *Ceratodon purpureus*, *Erythrophyllum rubellum*, etc., and a few species belonging to the genus *Bryum*, *Catharinea*, *Dicranella*, *Fissidens*, *Funaria*, *Mniobryum*, *Phascum*, *Pohlia* and *Pottia*.

On the loess hills having a southern exposition the xerothermal community of *Tortula velenovskyi* is found to grow. The moss species belonging to this community have a special adaptation, though in very mild forms, to the dryness and high amount of sunshine. Highly adaptable to dryness are the species belonging to the family Pottiaceæ (Pan-Chien, 1942). A minority (nearly 27.0%) of the moss species growing on loess land in Poland (115 species in all) represents mediterranean elements. The species specific to the Central European loess areas, like *Tortula velenovskyi*, represent, on the other hand, pannonic elements.

The distribution of spores is brought about either by the agency of winds (anemosporia), water (hydrosporia) or insects (zoosporia), and depending upon the circumstances any one of these species can make use of either or all of these helping agents.

Dept. of Systematic Botany, K. KARCZMARZ.
and Plant Geography,
Maria Curie Skodowska University,
Lublin (Poland), June 12, 1961.

1. Gams, H., *Manual of Bryology*, The Hague, Martinus Nijhoff, 1932.
2. Karczmarz, K., *Fragm. Flor. Geobot.*, Kraków, 1960, **6** (4), 573.
3. —, *Ann. Univ. MCS. Lublin.*, 1961, **13** (4), 376.
4. Pan-Chien, Chen, *Hedwigia*, Dresden, 1942, **80**, 1.

REVIEWS

Tables of the Riemann Zeta Function. By C. B. Haselgrove and J. C. P. Miller. (Published by the Royal Society at the University Press, Cambridge), 1960. Pp. xxii + 80. Price 50 sh. net.

The Riemann Zeta function $\zeta(s)$ is defined by the series $\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s}$ for $\text{Re } s > 1$. Ever

since Riemann described it a century ago, this function has been studied intensively and its interest is still not exhausted in view of the challenges which some of the unproved conjectures regarding the zeroes of the zeta function pose to the mathematicians. The behaviour of the zeta function is notorious for its irregularities and from the numerical point of view, it is very difficult to compute. It was not until the advent of electronic computing machines that it was possible to compute the function for more than a few small values of the argument.

The present tables give values of $\zeta(s)$ and related functions to six decimals for values of s on the 'critical line', that is $s = \frac{1}{2} + it$, and on the line $s = 1 + it$ for $0 \leq t \leq 100$.

Values of the signed modulus $Z(t) = \pm |s(\frac{1}{2} + it)|$ are given for $t = 0$ (0.1) 1,000 and for four short ranges of t , two near 7,000 and 17,000 where certain peculiarities are exhibited and two near 100,000 and 250,000 as typical ranges for large arguments.

The numerical values in the tables have already been used in a disproof of the conjectures of Polya and Turan. Inspection of the tables will lead to closer knowledge of this fascinating function and will encourage further conjectures about its behaviour. K. S. V.

Mechanics, Second Edition. By Keith R. Symon, University of Wisconsin. (Addison-Wesley Publishing Company, Inc.), 1960. Pp. XIV + 557. Price \$ 10.50.

The present edition (1960) of the book contains the following twelve chapters:

Chapter 1: Elements of Newtonian Mechanics; Chapter 2: Motion of a particle in one dimension; Chapter 3: Motion of a particle in two or three dimensions; Chapter 4: The motion of a system of particles; Chapter 5: Rigid bodies, Rotation about an axis, Statics; Chapter 6: Gravitation; Chapter 7: Moving co-ordinate

systems; Chapter 8: Introduction to the mechanics of continuous media; Chapter 9: Lagrange's equations; Chapter 10: Tensor Algebra, Inertia and Stress tensors; Chapter 11: The rotation of a rigid body; Chapter 12: Theory of small vibrations.

The last three sections of Chapter 9 deal respectively with the Lagrange's equations of the vibrating string, Hamilton's equations and Liouville's theorem and the Chapters 10, 11 and 12 are the additions over the first edition (1941).

In these twelve chapters the author builds up the subjects of Mechanics from fundamental principles up to the standard required for undergraduate students of the American universities intending to proceed to advanced studies in Physics. Keeping this purpose in view, the author includes at proper places brief but clear discussions of the mechanical problems associated with some of the physical topics like harmonic oscillator, two coupled harmonic oscillators, central orbits, Rutherford scattering by charged particle of finite mass, the two-body problem, the restricted three-body problem, normal modes of oscillations, Betatron oscillations in an accelerator. In fact one of the characteristic features of the book is that the author sets a problem in a general way and then derives from it as particular cases the physical problems of diverse nature. This approach not only provides the reader with information about these physical problems, but also brings out clearly the universal applicability of a mathematical method.

The book is more or less self-sufficient and provides also the necessary knowledge of the mathematical tools like vectors and tensors.

P. L. BHATNAGAR

The Real Projective Plane, Second Edition. By H. S. M. Coxeter. (Cambridge University Press), 1960. Pp. viii + 226. Price 18 sh.

This is an introductory university text-book on projective geometry, including a thorough treatment of conics and a rigorous presentation of the synthetic approach to co-ordinates. The restriction to real geometry of two dimensions makes it possible for every theorem to be adequately represented by a diagram. The subject is used to illustrate the development of a logical system from primitive concepts and simple

axioms. Accordingly the treatment is mainly synthetic: analytic geometry is confined to the last two of the twelve chapters. The eighth and ninth chapters show how projective ideas can be used as a basis for metrical geometry.

In this second edition, several errors contained in the first edition have been corrected. There is an improved treatment of degenerate polarities, of the inside and outside of a conic, of the condition under which a quadrangle may be convex with respect to a line, and of Klein's classification of geometries according to the groups of transformations under which their properties are invariant.

V.

Theoretical Physics in the Twentieth Century
—A Memorial Volume to Wolfgang Pauli.
Edited by M. Fierz and V. F. Weisskopf.
(Interscience Publishers, New York), 1960.
Pp. x + 328. Price \$12.00.

This book comprises of a series of articles written by eminent scientists on topics that were either inspired by or are associated with Pauli's work. It was originally intended to be a commemoration volume to celebrate the 60th birthday of Pauli, but unfortunately it ended as a memorial volume since the untimely death of Pauli occurred in the meantime. Pauli made a name for himself even at an age of twenty by writing an article on relativity theory in the *Encyclopaedia*, and this even today stands as one of the best expositions on the subject. Pauli's best known works are the Exclusion Principle and the Neutrino Hypothesis but a perusal of this in the bibliography of Pauli given at the end of the volume will indicate the width of his interests.

The book starts with a brief foreword by Professor Niels Bohr who writes on the contributions of Pauli to physics. The other contributors to the volume are Kronig, Heisenberg, Wentzel, Villars, Peierls, Fierz, Landau and C. S. Vu. Some of the articles have a personal and historical touch, but practically all are reviews on topics that were stimulated by Pauli's contributions. The book will provide a very interesting reading to all physicists.

An Introduction to Astrodynamics. By R. M. L. Baker, Jr. and M. W. Makemson. (Academic Press, Inc., New York-3), 1960. Pp. xiv + 358. Price \$ 7.50.

With the advent of artificial satellites, space vehicles, and interplanetary stations astrodynamics has come to the forefront as a separate branch of celestial mechanics with a practical

bias. In a restricted sense, astrodynamics may be defined as the engineering or practical application of celestial mechanics to the contemporary problems of space vehicles and their trajectories. At present there exists no text-book of an introductory type that can be used for teaching at college level on this subject which is growing in importance.

The book under review is meant to serve this purpose and the approach is more specific than general.

The book is broadly divided into two parts, the first part dealing with fundamentals include chapters on minor planets, comets, geometry and co-ordinate systems, and various constants coming under the categories geocentric, selenocentric, heliocentric, and planetocentric which are required to predict orbits of space vehicles. The second part includes chapters on orbit determination, the *n*-body problem, perturbations, and non-gravitational and relativistic effects. There is also a chapter on observation theory dealing with the requirements of rapid and accurate observation of space vehicles by optical as well as electronic instruments. The last chapter deals with the application of theories developed in earlier chapters to the particular case of interplanetary orbits. Students will find the exercises given at the end of the book useful to guide their understanding of the text.

A. S. G.

X-Ray Microscopy. By V. E. Cosslett and W. C. Nixon. (Cambridge University Press, London, N.W. 1), 1960. Pp. xiv + 406. Price 80 sh.

Although the possibilities of using X-rays for microscopical investigations have been known for sometime, it is only within the last few years that X-ray microscopy has become a practicable research tool. The two characteristic properties of X-rays, namely, their short wavelengths and their high penetrating power (having no charge as contrasted to electron beams), make them peculiarly suitable for this purpose, and the useful range of X-ray microscopy in its various applications will bridge the gap between optical microscopy on the one side and electron microscopy on the other. In dealing with short wavelengths of high penetration several difficulties will have to be overcome, the chief among them being the method of focusing. Considerable research work is being done on the subject and the perfecting of the technique may be said to be still in the evolving stage. Literature on the subject is scattered in various journals and hence a consolidated review on X-ray microscopy will be a timely publication.

In this context the present book *X-ray microscopy* by Cosslett and Nixon, who themselves have made significant contributions in this field, will be welcomed by all those who employ this technique in their investigations.

The subject-matter of the book can be divided into three main parts: (1) Principles involved in the three main methods of X-ray microscopy, namely, Contact radiomicrography, Reflection microscopy, Point projection method; (2) Practical details in using the technique for qualitative and quantitative microscopic work; and (3) examples of applications in biology, medicine, metallurgy and technology. There are also chapters on the production of X-rays, and on microdiffraction procedures. The last chapter on new experimental methods describes amongst other things, different forms of image intensifiers, image conversion X-ray microscope, focusing by back-scattered and forward scattered electrons, and contact radiomicrography with electron microscope enlargement. The book contains 32 plates besides a large number of line diagrams.

The book will be generally welcomed by all X-ray microscopists and microanalysts, but from the point of view of its appeal to the general students the reviewer feels that the subject-matter of the book could have been better arranged, and also the book could have been made more self-contained by supplying essential information of a fundamental nature. To cite one example, the student-reader finds early in the book (Figures 1 and 3) that focusing is effected by electron lens. To know more about electron lens he consults the index which refers him to p. 273, where he is shown § 11·3 for a brief description, where again he is directed to References on p. 385 and p. 393 which give him the names of the standard text-books to be consulted on the subject.

A. S. G.

Structure and Function of Muscle. Edited by G. H. Bourne, Vol. II. *Biochemistry and Physiology.* Pp. xiv. + 593. Price 118 sh. Vol. III, *Pharmacology and Disease.* (Academic Press Inc. (Lond.) Ltd., 17, Old Queen Street, London, S.W. 1), 1960. Pp. xiv + 489. Price 107 sh. 6 d.

The two volumes under review constitute the bulk of treatise of three volumes edited by Dr. G. H. Bourne and designed to cover in detail all aspects of current knowledge of muscle tissue. Twelve articles in the second volume relate to biochemistry and physiology of muscle, while in the third volume, there are thirteen articles dealing with pharmacology and disease of muscle.

The second volume opens with an article by A. C. Szent-Gyorgyi, wherein he discusses the characterization and reactions of the myofibrillar proteins, the amino-acid composition, end-group and sequence studies and polypeptide chain configuration of the fibrous muscle proteins. The biochemistry of muscular action is reviewed by D. M. Needham who gives a detailed account of the interaction of adenosine triphosphate and actomyosin in muscle contraction and mechanism of action of Marsh factor in relaxation. The function of sarcosomes which are the respiratory granules of muscle, the mechanisms of energy-yielding reactions, the properties of the isolated sarcosomes are described by E. C. Slater.

In his article on the role of acetyl choline system in neuromuscular junction, David Nachmansohn gives a critical resumé of the present day knowledge and concepts concerning the mechanism of conduction of nerve impulses in general and on the basis of this information, makes an attempt to evaluate the differences and similarities of the properties and function of the acetyl choline system in synaptic and neuromuscular transmission. Special topics such as the thermodynamics and biophysics of muscle, the physiology of muscular exercise and physiology of the heart have been included.

In Volume III, the first two articles deal with the effect of drugs on smooth and striated muscle and on myocardial contractility. Among the subsequent chapters which deal with abnormal muscle, special mention may be made of subjects like the effect of nutritional deficiencies upon muscle, changes in muscle due to ageing and after death and clinical and genetic aspects of muscular and neuromuscular diseases. The volume is aptly concluded with some general comments on muscle by A. Szent-Gyorgyi who has made outstanding contributions to our knowledge of the mechanism of muscle contraction.

Research workers, teachers as well as students will find in these two volumes a mine of information on the biochemistry, physiology, pathology and pharmacology of skeletal, smooth and cardiac muscle.

P. S. SARMA.

Indian Essential Oils—A Review. By A. K. Menon. (Council of Scientific and Industrial Research, New Delhi, India), 1960. Pp. viii + 89. Price Rs. 7·00. 10 sh.

The above book of 89 pages is a valuable publication of the progress made in the field of essential oils, aromatic chemicals and related spice oils industry mainly during the period 1946-59. This is a second report by the C.S.I.R.

in this field, the first of which was published in 1946, by P. A. Narielwala and J. N. Rakshit.

The present volume has dealt with, in all, 29 essential oils, 5 spice oils and 29 natural isolates, attars and aqueous products, all of which have been discussed in four chapters under appropriate headings. Details of cultivation of the oil-bearing plants and the methods of extraction of their perfumes are given in most of the cases along with the names of the authors, firms and institutions connected with the development and practice of these methods. Analytical data along with the chemical compositions of the oils are also given in many cases.

The most valuable part of this book is its almost exhaustive bibliography of 575 plus 5 original investigations published in India during the period from 1908 up to 1959.

The statistical data given as appendices on production, consumption, export and import of essential oils and related products in India are informative and revealing.

P. RAMASWAMI AYYAR.

Insulin—*British Medical Bulletin*, Vol. 16, No. 3.
(Medical Department, British Council, London,
N.W. 1), 1960. Pp. 175-264. Price 20 sh.

This monograph on 'Insulin' commences with an interesting historical survey of 'The development of Insulin' by Charles H. Best, one of the two co-discoverers of this hormone. "The elucidation of chemical structure of the insulin molecule" by Sanger is a lucid presentation of the sequential progress, culminating in the successful structural analysis of this polypeptide hormone, and reveals the chemical basis of the variations in insulins obtained from different species of animals. These pioneering studies have resulted in the application of similar techniques to the elucidation of the structure of other protein hormones. Harris details the chemistry of the pituitary polypeptide hormones, oxytocin, vasopressin, corticotropin and the melanocyte stimulating hormones. In the metabolic studies pertaining to the inactivation and degradation in tissues of insulin, glucagon and other peptide hormones, the technique of utilising "iodinated peptides with radioisotopes ^{131}I " has been employed.

In spite of extensive use of insulin over the last four decades, metabolism and mode of action of insulin is still far from clear. Radioactive tracer studies and other recently developed biochemical techniques have now been applied for the elucidation of these problems. The results obtained are reviewed in chapters on the action

of insulin on carbohydrate, protein and fatty acid metabolisms.

The types of insulins commercially available with their scope and limitation in therapy and the illustrated account of 'reactions to insulin' present features highly interesting to clinicians. The need for a cautious approach to the use of sulphonamide derivatives and the diguarides and the likely laboratory finding of a normal or low blood sugar level with severe acidosis and ketosis has been emphasized. M. SIRSI.

Sex Differentiation and Development. Memoirs of the Society for Endocrinology. No. 7. Edited by C. R. Austin. (Cambridge University Press), 1960. Pp. 198. Price 45 sh.

We welcome this volume on sex differentiation as a worthy successor to the series published by the Society for Endocrinology from time to time. This memoir embodies the proceedings of a Conference held in London in April 1958 to survey the state of knowledge of sex in its various forms and implications. The symposium deals with four main topics, namely, mechanism of sex determination, differentiation of germ cells, manifestations of sex and sexual anomalies. The very broad and comparative survey of sex in animals ranging from bacteria to man touches upon interesting aspects of manifestations of sex in honey-bees, crustacea, fish and higher vertebrates.

Dr. Butler gives a fascinating account of sex differentiation and castration effects in the honey-bee. He has pointed out that the presence of the queen bee through the agency of an 'external hormone' contained in the so-called 'Queen substance' inhibits the development of the gonads in other females. Genetic sex determination is a central theme in the contribution of a number of speakers. The possibility of controlling sex ratio at conception either by phenotypic differentiation of X and Y bearing spermatozoa or by electrophoretic separation has been discussed by Dr. Beatty and Dr. Lewin. This aspect of study has opened up a new field of research in the control of sex. Sexuality in bacteria has been discussed by Dr. Hayes with particular reference to the processes by which transference of genes from donor to recipient cells takes place. The use of sex chromatin as a marker for the determination of genetic sex has assumed considerable importance in the diagnosis of genital abnormalities. The application of this method for the recognition of the variations of Turner's syndrome and Kleinfelter's syndrome has been reviewed. It appears from

these discussions that gonadal dysgenesis can affect either chromosomal males or females; only such cases in which chromosomal sex is contrary to phenotypic sex should be considered as inter-sexes. The role of hormones, particularly from the medullary component of the foetal gonad in the differentiation of sex and genital abnormalities has been reviewed by Dr. Jost.

Dr. Parkes and Miss Parrot have given an interesting account of the method for orthotopic ovarian grafts to demonstrate in a convincing and elegant manner the viability of ova in ovaries previously frozen. The origin and development of oocytes in foetal and mature mammals is discussed by Sir Solly Zuckerman who points out that in the mammals, as in all the vertebrates, the oocytes develop extra-embryonally and migrate to the presumptive intra-embryonal gonadal region and that oogenesis, unlike spermatogenesis, ceases when reproductive life begins. 'Integumentary sex characters in vertebrates' is discussed by Dr. Harrison Mathews though he has not referred to the factors regulating the development of these characters. The role of gonadal and pituitary hormones, in conjunction with psychological factors, in the development and maintenance of these sex characters in vertebrates, needs further investigation.

Dr. C. R. Austin, the Editor and organizer of the symposium, is to be congratulated for the choice of the subject and for the excellent get-up of the book. There is no doubt that this number of the Memoirs of the Society for Endocrinology will be valuable to the research worker as well as to the University teacher interested in the study of the various facets of biology of sex in animals.

M. R. N. PRASAD.

Books Received

From: (Interscience Publishers, Inc., 250, Fifth Avenue, New York-1, N.Y.):—

Extractive Metallurgy of Copper, Nickel and Cobalt. By Paul Queneau, 1961. Pp. xv + 647. \$ 22.50.

Turbulence—Classic Papers on Statistical Theory. Edited by S. K. Friedlander and L. Topper, 1961. Pp. ix + 187. Price \$ 6.00.

Interscience Tracts on Physics and Astronomy, No. 10—General Relativity and Gravitational Waves. By J. Weber, 1961. Pp. viii + 200. Price: Cloth \$ 4.50. Paper \$ 2.50.

Advances in Pest Control Research (Vol. IV). Edited by R. L. Metcalf, 1961. Pp. vi + 347. Price \$ 12.50.

Treatise on Analytical Chemistry, Part II—Analytical Chemistry of the Elements, Vol. I. Edited by I. M. Kolthoff, and P. J. Elving, 1961. Pp. xxi + 471. Price \$ 16.00.

From: (Cambridge University Press, 200, Euston Road, London, N.W. 1) :—

The Eleventh Symposium of the Society for General Microbiology—Microbial Reaction to Environment. Edited by G. G. Meynell and H. Gooder, 1961. Pp. 416. Price 42 sh.

Memoirs of the Society for Endocrinology, No. 11—*Cell Mechanisms in Hormone Production and Action.* Edited by P. C. Williams and C. R. Austin, 1961. Pp. x + 173. Price: Cloth 40 sh. Paper 25 sh.

The Evolution of Physics. By A Einstein and L. Infeld, 1961. Pp. xvi + 302. Price 13 sh. 6 d.

From: (Chapman and Hall, 37, Essex Street, London, W.C. 2; India: Asia Publishing House, Nicol Road, Bombay-1) :—

Analysis of Deformation (Vol. 4), *Waves and Vibrations.* By K. Swainger, 1959. Pp. xxvi + 370. Price 75 sh.

Impulse-Voltage Testing. By W. G. Howley, 1959. Pp. xvi + 183. Price 32 sh.

From: (Academic Press, Inc., Pub., 111, Fifth Avenue, New York-3; India: Asia Publishing House, Nicol Road, Bombay-1).

Liquid Rockets and Propellants. Edited by L. E. Bollinger, M. Goldsmith and A. W. Lemmon, Jr., 1960. Pp. xv + 682. Price \$ 6.50.

The Chemistry of Lignin. By F. E. Brauns and D. A. Brauns, 1960. Pp. x + 804. Price \$ 18.00.

Mineral Metabolism an Advanced Treatise, Vol. I, Part A—*Principles, Processes and Systems.* Edited by C. L. Comar and F. Bronner, 1960. Pp. xv + 386 + 30. Price \$ 12.00.

Electromagnetic Wave Propagation. Edited by M. Desirant and J. L. Michiels, 1960. Pp. xiii + 730. Price \$ 22.00.

Oxide Ceramics—Physical Chemistry and Technology. By Eugene Ryshkewitch, 1960. Pp. viii + 472. Price \$ 16.00.

The Harvey Lectures, 1958-59 and 1959-60—Series, 54, 1960. Pp. xiv + 312. Price \$ 7.50; Series, 55, 1961. Pp. xiv + 257. Price \$ 8.00.

Nuclear Spectroscopy (Part A). Edited by F. A. Selove, 1960. Pp. xxi + 621. Price \$ 16.00.

X-Ray Analysis of Organic Structures. By S. C. Nyburg, 1961. Pp. xii + 434. Price \$ 13.00.

SCIENCE NOTES AND NEWS

The Natural Control of the Potato Tuber Moth

Sri. K. K. Nirula, Central Potato Research Station, P.O. Sahay Nagar, Patna (Bihar), writes :

Lizards *Hemidactylus brooki* Gray and *H. leschenaulti* Dum. and Bibr. were found preying upon the adults and larvae of the potato tuber moth *Gnorimoschema operculella* Zell., a very serious pest of stored potatoes in the plains of India. The number of adults and larvae of *G. operculella* caught daily per lizard ranged up to 28·5.

In an underground potato store at Central Potato Research Station, Patna, very high populations of *G. operculella* were considerably reduced by these lizards during the summer months of 1959 and 1960. These lizards appear to be a valuable addition to the already known biological control agents of *G. operculella*.

Hosts of the Root Parasite *Aeginetia indica* Linn.

Sri. K. S. Venkataramani, Dowescroft Cottage, Quail Hill, Coonoor, writes :

In their recent note on the root parasite *Aeginetia indica* Linn. (*Curr. Sci.*, 1961, 30, 191) the authors, Chavan, *et al.*, remark that they have been able to trace only one host plant, *viz.*, *Dioscorea* sp. Last year, while, collecting plant specimens in the Mudumalai forests of the Nilgiris (elevation ca. 1,000 m. above the M.S.L.), I noticed several groups of *A. indica* scattered here and there under bamboo clumps (*Bambusa arundinacea* Willd.). As this root parasite is not a very common one, I availed myself of that opportunity to examine the nature of its parasitism and found that there was organic union between the bamboo roots and the roots of the parasite. Evidently they were parasitic on bamboo roots. The roots of the parasitized bamboo appeared normal, except that a small swelling was noticed at the region of the union. All the specimens I observed were under bamboo clumps, but in one instance the root parasite was seen associated with a root which was undoubtedly not that of a monocot. I, however, failed to trace the origin of the host root. *Dioscorea pentaphylla* Linn. is very commonly seen in the bamboo forests of Mudumalai, but I am not certain whether the unknown host root could have been that of this plant. As Chavan

et al. mention, it seems unlikely that *A. indica* is a cosmopolitan root parasite, but one can never be dogmatic in this until more critical observations are made in several centres.

Low-Cost Reagent for the Extraction of Ascorbic Acid from Potatoes

Messrs. B. M. Gangwar and K. Swaminathan, Agricultural Chemistry Laboratory, Central Potato Research Station, Patna (Bihar), write :

Metaphosphoric acid is the ideal extractant for ascorbic acid from fruits and vegetables, but its cost prohibits its use for the analysis of large number of samples in a low-budget laboratory. Ponting and Wokes recommended 2% oxalic acid, which is considerably cheaper, as a substitute reagent. It was, however, found to be unsuitable for the extraction of ascorbic acid from potato tubers. This difficulty was overcome by using a mixture of metaphosphoric and oxalic acids.

The minimum proportion of metaphosphoric acid, which on incorporating to a 2% oxalic acid solution would be just sufficient to give clear extracts, was worked out.

It was found that a mixture of 0·25% metaphosphoric acid in 2% oxalic acid would be an efficient low-cost extractant for use with potatoes. Its choice was further justified when recovery studies showed that with this extractant, exactly similar proportion of the ascorbic acid added before extraction was recovered, as with the 10% metaphosphoric acid reagent.

Effect of Boiling Fishing Net Twines

Sri. G. K. Kuriyan and (Miss) P. J. Cecily, Central Fisheries Technological Research Station, Cochin-5, write :

Net materials of vegetable origin, particularly those of Cotton (*Gossypium* sp.), Sunnhemp (*Crotalaria juncea*) and Italian hemp (*Cannabis sativa*), due to their susceptibility to rotting by bacterial and fungal action, are usually treated by Indian fishermen with "tannins" to ensure their longevity. The sources of "tannins" are barks, twigs, leaves and seedcoats of different indigenous plants and trees. They are extracted by boiling the material in water or by exposure of admixture of the material and water to the sun for a few days. The netting fabric is treated in the hot, cold or pre-cooled extract. While some fishermen prefer the 'hot dip' process to obviously accelerate the amount of impregnation

of the preservative, others use a cold dyeing bath under the belief and personal conviction that heat might affect the strength property of the treated twine. To ascertain the possible effect of heat or boiling on the resultant strength, netting twines of cotton, sunnhemp and Italian hemp after determination of their original breaking strength, both in the dry and wet conditions, were immersed in boiling water for periods of 20, 40, 60, 80, 200 and 120 minutes and their strength determined after such exposure. Results showed that there was apparently no effect on the strength of the twines by boiling up to 120 minutes.

Tenth Anniversary of Turkmenia's Academy of Sciences

Since the establishment of Turkmenia's Academy of Sciences nearly ten years ago, it has become a large scientific centre. It has 22 scientific research institutes, and has provided the republic with scientific workers. Among them are 38 active and corresponding members, more than 150 doctors and candidates to sciences. The Institutes of the Academy are busy with problems which are of great significance for the development of Soviet Turkmenia's economy and culture. These include the solar energy, combined problems connected with the building work and the exploration of the Turkmenian Canal, finding useful deposits, and the study of history, language and folklore of the Turkmenian people.

Several institutes and laboratories are connected with industrial and agricultural enterprises of the republic. Scientists are giving practical assistance to the production workers and are summarising the experiences of the advanced working groups.—(USSR Information Department, New Delhi.)

International Conference on the Physics of Semiconductors

The Institute of Physics and the Physical Society on behalf of the International Union of Pure and Applied Physics, and the British National Committee for Physics is arranging an International Conference on 'The Physics of Semiconductors', which will be held at the University of Exeter from 16-20, July, 1962. The Conference is planned to follow the previous sequence of Conferences on the physics of semiconductors, which were held in Reading in 1950, Amsterdam in 1954, Garmisch in 1956, Rochester in 1958 and Prague in 1960.

Accommodation will be provided in Halls of Residence at the University. Further information regarding the Conference may be obtained

from the Administration Assistant, The Institute of Physics, and The Physical Society, 47, Belgrave Square, London, S.W. 1.

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Physics to Shri K. V. V. Ramana for his thesis entitled "Studies on Ionospheric Drifts and Absorption"; and D.Sc. Degree in Chemistry to Messrs. P. V. R. Subrahmanyam and M. Balakeswara Rao for their theses entitled "Studies on the Nitrogen Changes in Sewage and Sludges" and "Studies in the Photochemical Sensitivity of Uranium (VI)—Carboxylic Acid Mixtures" respectively.

Colloquium on Documentation

A one day colloquium on 'Documentation' was held under the auspices of the Electronics Research and Development Establishment (LRDE), High Grounds, Bangalore-1, on the 28th June 1961. It was presided over by Prof. S. R. Ranganathan, and the delegates, over 60 in number representing about 30 research, scientific and technical organisations from various parts of India, were welcomed by Col. B. M. Chakravarti, the Director of Establishment.

The colloquium discussed the problems encountered in the Technical Information Centre of the LRDE on aspects of 'Storage', Retrieval, and 'Dissemination' of technical and scientific information.

The proceedings of the colloquium, to be brought out shortly, will be available, on request, from the Director.

Crystal Structure of He⁴ and He³

In the course of investigations of the thermal properties of solid He⁴, Duggdale and Simon observed a first order transition whose equilibrium line cut the melting curve at 14.9°K. (Proc. Roy. Soc., 1953, 218 A, 291). As the heat of transition was found to be very small, about 0.8 cal./mole, the transition was assumed to correspond to a change of crystal structure from hexagonal to cubic close-packed.

Whether helium solidifies in the cubic closest packed structure as the other inert gases do has been of theoretical interest. Recently Mills and Schuch (Phys. Rev. Letters, 1961, 6, 263) investigated by X-ray diffraction method, the structure of the new phase of He⁴ occurring at temperatures and pressures above 14.9°K. and 1,100 atmosphere. They used the cryostat and camera arrangement, specially adapted to take oscillation photographs, for studying the crystal structure at low temperatures. They found that all the

reflections obtained could be indexed on the basis of a cubic lattice. The indices were always all even or all odd, indicating the face-centered cubic structure.

Prompted by this success, they further investigated the high pressure and temperature structure of He^+ (*Phys. Rev. Letters*, 1951, 6, 596). They find that He^+ under high pressure also transforms to the face centered cubic structure. Data at 1374 K. and 1693 atmosphere gives the length of the edge of the cube as $a_0 = 4.242 \pm 0.016 \text{ \AA}$. For He^+ the hep-fcc transition occurs at a higher pressure than it does for He^4 . It was observed that He^+ at 1593 K. and 1341 atmosphere still had the hep structure.

Hyperon Stars

The extension of V. A. Ambartsumian's hypothesis of stellar evolution led G. S. Saakyan (*Priroda*, 1960, 11, 14) to develop a new hypothesis of stellar evolution based on the findings of certain recent discoveries of new elementary particles. According to this hypothesis dense stars of the type of 'white dwarf' on further contraction become neutron stars. During this process their density changes from approximately 10^4 g/cm^3 to about 10^5 g/cm^3 . With a further increase of density to 10^6 g/cm^3 these stars become hyperon stars representing a more stable state under such conditions. The mass of such hyperon stars in equilibrium is approximately the same as that of the Sun, while the size of their radii is of the order of a few kilometres. Only the central part of such stars contains hyperons. The outer zone is made of neutrons, while the outermost part is made of bare nuclei and electrons. The enormous pressure inside such stars is balanced by the force of gravity, but when such an equilibrium is disturbed hyperon stars are liable to explode with a terrific violence, not unlike the explosions leading to the formation of the 'nova' stars (*Nature*, 1961, 190, 961).

Discovery of a White Dwarf Cluster

The Byurakan Astrophysical Observatory of the Armenian Academy of Sciences has recently announced the discovery of a great cluster of white dwarfs. It was detected on pictures taken with the 21-inch Schmidt telescope. The cluster has an elongated form with its largest linear diameter about 25 light years. It was discovered in the Lyre constellation about 800 light years away from the earth.

White dwarfs are super-dense stars of low luminosity and high temperature. So far, only about 300 isolated stars of this type have been known. This is the first instance when a whole

cluster of white dwarfs has been discovered. As the white dwarf represents the last phase in the life of a star, the cluster must be very old—more than ten thousand million years. It is apparently older than other constellations of our galaxy. This determination has provided us with new data on the age of our galaxy. (USSR News.)

Origin of Ocean Basins and Continents

Current ideas on the problem of the origin of ocean basins and continents are based on well-known hypotheses such as, the tidal resonance theory of Darwin, involving creation of the Pacific Ocean by escape of the Moon, the theory of migrating continents originated by Taylor and Wegener, and the various theories based on thermal convection. Most such theories were devised without taking into account a discovery of the last decade that the Mohorovicic discontinuity rises from its depth of about 33 km. under the continents to within about 5 km. from the floors of the oceans. This fact implies a profound difference in the structures of ocean basins and continents, which creates grave difficulties for most theories of the origin of these features, in particular for the theory of migration of continents.

J. J. Gilvarry recently suggested that the circular lunar maria are simply large meteoritic craters with sedimentary floors, excavated by explosive impact of meteorites on the lunar surface in the presence of a hydrosphere. He now proposes an exactly analogous mode of formation of ocean basins, as the results of explosive impact of large meteorite at a pristine time when the hydrosphere covered the earth to a roughly uniform depth. The disparity in the levels of the Mohorovicic discontinuity under continents and oceans enters the theory as an integral part.

The article is based on a reconstruction of the mensuration of the pristine oceans, and a correlation of their dimensions with those of the lunar maria, lunar craters (of Class V), and meteorite and explosion craters in water. Thus, the presence of a terrestrial hydrosphere at the time of formation of the ocean basins is an essential element in determining the relative dimensions of the pristine craters.

According to Gilvarry's hypothesis the primordial ocean basins were simply the largest meteorite craters ever formed on the earth, entirely analogous to the circular lunar maria. The primordial continents were simply structures corresponding to the rims of these craters. (Nature, 1961, 190, 1048.)

Odour and Molecular Vibration

The hypothesis has been put forward that odours of organic substances may be correlated with the low-frequency vibrations of their molecules. The similarity in the low-frequency Raman Spectra of Nitrobenzene and Methyl salicylate has prompted R. H. Wright to devise an indirect method of testing his hypothesis. The low frequency Raman lines in the two liquids are:

Nitrobenzene	183	408 cm. ⁻¹
Methyl salicylate	185 263 356	428 cm. ⁻¹

On the above hypothesis the odours of these two substances should be basically similar but with the odour of methyl salicylate altered from almond-like to wintergreen by the additional frequencies not possessed by nitrobenzene. It follows that a small amount of methyl salicylate added to nitrobenzene should be perceived by the nose more easily than a small amount of nitrobenzene added to methyl salicylate, provided due allowance is made for the different absolute thresholds of the two substances.

Wright's series of tests consisted in recording the reactions of twelve observers who were asked to smell solutions of different concentrations and identify the one that was different, and also to smell different concentrations of one liquid against a background of the other. The results showed that the wintergreen odour of methyl salicylate conceals the almond odour of nitrobenzene 10 times more effectively than the almond odour conceals the wintergreen odour. The effect is not large; but it is distinct, and it is in the direction predicted by the vibrational theory of odour.—(Nature, 1961, 190, 1101).

Collision of High Energy Particles with Light Nuclei

Results of experiments carried out at the high altitude research station of the Uzbek Academy of Sciences go to show that during interaction of high energy particles with light nuclei, the newly formed secondary particles get, on the average, less than 50% of the energy. There is very weak relation, if any, between the energy of the primary particles and that fraction of the energy which the neutral pi-mesons get during the collisions. These conclusions are at variance with the results obtained by other workers. The difficulty lies in evaluating the energy of the primary particles. In the Russian

experiment carried out at an altitude of 3,200 metres, a calorimetric method of evaluation was used for measuring the energy of primary particles. The Cherenkov counters were used for this purpose for the first time.—(USSR News.)

Rotational Multiplets in the Oscillation Spectrum of the Earth

The free oscillations of the Earth are governed by gravitational and elastic forces. From the distribution of density $\rho(r)$ and the elastic constants $\lambda(r)$ and $\mu(r)$, as inferred primarily from seismic and from other geophysical data, it is possible to determine the oscillation frequencies (spectrum of the Earth) for the several proposed models of the Earth, e.g., Gutenberg model, Bullen B model. This has been done in recent years by Pekeris, Alterman and Jarosch.

Occasion to test the results presented itself when the strain seismograms and gravimetric records of the Chilean earthquake of May 22, 1960, were made available. In the reports on this earthquake presented by Press *et al.*, and Slichter *et al.*, the former identified 52 lines in the strain seismograms, and the latter 49 lines in the gravimetric records. They reported that the gravest modes $n = 2$ (53.7 min.) and $n = 3$ (35.5 min.) appear as doublets in the strain-meter and gravimetric spectra. It was then suggested that the splitting is due to the earth's rotation.

While the Zeeman Effect furnishes ample experimental verification of the electromagnetic part of Larmor's theorem, an experimental demonstration of the mechanical counterpart has been wanting. Now Pekeris *et al.* (Phys. Rev., 1961, 122, 1692) have extended their previous analysis of the free oscillations of a non-rotating self-gravitating elastic earth, by carrying out a first-order perturbation calculation of the effect of slow rotation on the frequency.

Their analysis yields the result that the degenerate frequency $\sigma_0(n)$ in the absence of rotation is resolved by slow rotation into $(2n+1)$ lines, the separation intervals being proportional to the angular velocity of the rotation of the Earth. The Chilean earthquake results are shown to be in conformity with the theoretical deductions, thus proving the mechanical part of Larmor's analogy.

556-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00 ; £ 1-4-0 ; \$ 4.00.

EXTRACTING ELECTRICITY FROM FLAMES

IAN FELLS

Department of Fuel Technology and Chemical Engineering
University of Sheffield, England

MAN has known about and pondered on the nature of fire almost since the beginning of civilization. Some of the first scientific experiments carried out on flames were reported by Gilbert, physician to Queen Elizabeth I, in his book *De Magnete*, published in London in 1600. He showed that flames were electrically charged. It is precisely this electrical property of flames that is the basis of the new method of electric power generation called, rather forbiddingly, magnetohydrodynamics (M.H.D.).

Conventional methods for producing electricity are notoriously inefficient, not because the plant (which usually incorporates some sort of hot fluid impinging on turbine blades causing them to rotate an armature in a magnetic field) is badly designed, but because the second law of thermodynamics restricts the efficiency to something like 40% of the available energy in the fuel. No amount of plant improvement can increase this efficiency unless a completely different generating principle is used.

Various methods for generating electricity more efficiently have been investigated from time to time. Grove, in 1800, was experimenting with fuel cells, and Faraday, in 1832, carried out the first experiment on power generation using a moving fluid conductor (M.H.D.).

In this experiment Faraday pumped a stream of mercury (the fluid conductor) through a magnetic field and was able to generate a current in an external circuit by placing in the mercury stream a pair of electrodes set at right angles to both the mercury flow and the magnetic field.

It is interesting to note that the two most modern methods of electricity generation, by means of fuel cells and by magnetohydrodynamics, both have their origins in experiments carried out more than 100 years ago.

Modern methods of M.H.D. power generation have dispensed with mercury as the moving fluid conductor and use, instead, a partially-ionised stream of combustion products, a flame, in fact. The ionisation occurring in flames, first noticed by Gilbert, is increased by the addition of small quantities of potassium, a metal which ionises easily and provides a further source of charged particles.

The first M.H.D. generators have been constructed along relatively simple lines. The

high-speed ionised gas stream is produced by what is, in effect, a rocket motor; fuel and oxygen are fed into a high intensity combustion chamber and the high temperature products of combustion, seeded with potassium to improve their conducting properties, are passed through a supersonic nozzle to increase their velocity (unfortunately this process causes a drop in temperature and hence in ionisation level) and then through a strong magnetic field. Current is taken out of the system by means of electrodes set at right angles to the gas stream and the magnetic field, as in Faraday's first experiments.

This type of generator suffers from several disadvantages: the cost of seeding the fuel with potassium is high, the temperatures in the system are very high (about 2,800° C.) and, although such temperatures can be used in a device without moving mechanical parts, serious material problems have to be solved, particularly if the generator is to have a long life. Another disadvantage of both the fuel cell and an M.H.D. generator in its simple form is that they produce low voltage direct current which must be converted to alternating current for general commercial use.

These problems are being solved in various ways. More sophisticated systems than the simple linear flow crossed field type are being developed, in which the driver gas stream is pulsed in various ways. This makes possible methods of current collection which do not necessitate putting electrodes in the high temperature gas stream itself; induction methods and parametric amplification are two other methods used.

The pulsed system also makes possible direct production of alternating current. The pulsed systems used are, in effect, streams of highly-ionised striations carried along by a high-velocity, non-conducting driver gas stream and they can be produced in various ways by suitable tailoring of the combustion system. Some of these principles can be used in closed cycles systems in nuclear piles which run at high temperatures and electricity can be generated more efficiently and, it must be said, more elegantly, than merely using the pile to raise steam for a conventional generator set.

The basic property of the gas stream, which is of importance in generator design, is the gas

conductivity, and a fundamental research programme is being carried out at the University of Sheffield and other institutions to examine the basic ion-producing mechanisms occurring in the flames, with the intention of encouraging them to produce more ions and thus do away with the need to add potassium. At the same time, more sophisticated methods of generator design are being developed.

The problems of electrical engineering and

materials technology involved are considerable. Nevertheless, there is tremendous scope for ingenuity in devising better and more efficient M.H.D. generators, and if the inventiveness applied to the improvement of turbo-generators during the last 50 years can be channelled into producing new methods of electricity generation it seems not unreasonable to expect that a practical and efficient M.H.D. generator will be developed.

THE HUMANITY OF MAN

THE 123rd Annual Meeting of the British Association for the Advancement of Science was held at Norwich, England, from August 30 to September 6, 1961, with Sir Wilfrid Le Gros Clark, F.R.S., Professor of Anatomy at Oxford since 1934, as its President.

Two things are essential to a correct appreciation of science today : firstly, the knowledge that it is a continuing activity, and secondly, that it is a co-operative activity. A scientist learns from all those who have gone before him and adds his knowledge to what they have already produced ; what he himself learns can only be fully used if it is known and shared by other scientists. Rightly, therefore, has Sir Wilfrid chosen as the title of his presidential address for this year's meeting "The Humanity of Man", to develop his thesis that the scientific attitude may be regarded as the culminating expression of the co-operative element in the human form of society.

Sir Wilfrid said : "Our task is to inculcate as widely as possible the spirit of freedom in scientific inquiry that gives full expression to deep-rooted altruism which is an essential attribute to the humanity of man, and which, I believe, can do more than anything else to preserve and intensify the feeling of harmony among all the peoples of the world. But we need to press ahead in our efforts with the utmost vigour, for the dangers which now threaten the unity of mankind are formidable indeed, and time is getting very short."

An essential prerequisite for any attempt at further unification for the good of mankind, said Sir Wilfrid, was the ability to give full expression to the impulse for co-operation which was so characteristic a feature of the humanity of man. That could only be made possible by

opportunities for free intercourse and free interchange of ideas among the peoples of the world.

He believed that science had a vitally important part to play in the promotion of such an ideal. The progress of science was essentially a result of co-operative human effort. Secretiveness was the very antithesis of the spirit of free inquiry implicit in the scientific method.

Dealing with international co-operation in scientific research, Sir Wilfrid said that one of the most important developments in science during recent years was the multiplication of international congresses and similar meetings. This is an expression of the urgent need felt by the scientifically-minded to maintain and extend still further contacts in the world which threaten to become disrupted by the conflict of national interests.

Sir Wilfrid advocated replacing "national" research by "regional" research for the study of problems of common interest in different geographical areas. The immediate and obvious advantages which accrue from regional research in relatively undeveloped countries are more likely than anything else to remove any possible feelings of suspicion or distrust towards the more developed countries from which assistance is received. He added : "If membership of the staff of regional institutions were unconditionally open to competent scientists of any community whose welfare depends on the results of its research projects, this would do much to engender an atmosphere of concord and to dissipate any tendency towards national rivalry which may exist." The touch of science, as he put it, can make the whole world kin.

The British Association has elected Sir John Cockcroft as its president for 1961-62.

POSSIBLE FUTURE USE OF BACTERIAL INOCULANTS IN INDIAN AGRICULTURE

PURNA CHANDRA*

College of Agriculture, University of Baghdad, Abu Gharib (Republic of Iraq)

[This article is based on the results of a study tour undertaken for two months during summer 1960 through the various Eastern European countries to learn about bacterial fertilizers where their use is in full swing.]

THE problem of proper fertilizer use exists worldwide, but it is more acute in a country like India where continued cultivation of soil for centuries has resulted in low levels of nitrogen and organic matter. The use of bacterial inoculants may overcome the shortage of plant nutrients thus increasing soil fertility and consequently food production. Before any mass scale step is taken very careful research is needed. In U.S.S.R. and other Eastern European countries the use of bacterial inoculants is already increasing and has resulted in raising the yields of wheat, cotton, lucerne, maize and other vegetable crops.^{2,3} Such a venture may prove to be worthwhile in India where the soil productivity is quite low in comparison to U.S.A., Japan, U.S.S.R., Canada, Netherlands, etc.

Increase in soil fertility is directly related to the micro-organisms present in the soil. Activity of these microbes is governed by a set of environmental conditions including pH, moisture, organic matter, temperature, food supply, etc. These soil micro-organisms decompose organic matter, produce "humus" and render the mineral constituents into forms more available for the plant. Hence the introduction of micro-organisms involved in the processes of "nitrogen transformations" and "rhizosphere activity" would be logical in order to raise soil productivity.

Azotobacter spp. is non-symbiotic, aerobic, nitrogen-fixing bacteria which is reported to fix yearly about 40-50 lb. of atmospheric nitrogen per acre.¹⁰ Kostychev⁸ was the first to suggest the manufacture of "Azotogen" or "Azotobacterin" from *Azotobacter*. He recommended its use on wheat, rye, oats, barley, potatoes and sugar-beets where its application brought about increases in the crop yields from 10 to 15%.⁸ Inoculation of such organisms into soil seems logical but there have been conflicting reports¹ about the inoculation of *Azotobacter* increasing crop yields. Such differences have been explained by Russian workers mostly on

the ecological factors and lack of proper agro-techniques when pointed out by the author. In Roumania the report of the "Bacterial Fertilizer Experimental Station"² indicated increases of 10% in grain, 65% in straw with the use of "Azotobacterin" alone. When it was applied in combination with N, P, K an increase of 92% in grain and 101% in straw was obtained. The director of this experimental station warned about the proper use of media and number of inoculants. The inoculation of 150-750 million bacteria per c.c. was satisfactory. There have been conflicting reports as to the amount of nitrogen fixed by *Azotobacter* and Meiklejohn⁶ emphasized the importance of *Clostridium butyricum* which is non-symbiotic, anaerobic nitrogen-fixing. This bacteria is reported to fix as high as 60 lb. of nitrogen yearly in one acre. If soil conditions were such that both organisms flourished, inoculation of that soil with these organisms might be twice as beneficial.

Rhizobium is a symbiotic nitrogen fixer which inhabits the root nodules of legumes. The quantity of nitrogen fixed by the various species of this organism is reported to be from 60 to 100 lb. in an acre yearly. The increase in yield by the use of inoculation of *Rhizobia*, popularly known as "Legume culture", has shown increases all over the world. In U.S.S.R. and U.S.A. this inoculant is called "Nitragin" and a concentration of 80-100 million *Rhizobia* per gram gave better results. However, locally isolated strains for lupine and lucerne are reported to be effective in Ukraine.⁴

Bacillus megatherium var. *phosphoticum*, a spore-former, is used for the production of "phosphobacterin". This group of bacteria was discovered by Menkina.⁷ This bacteria can decompose organic phosphorous compounds present in soil and accumulate phosphorus necessary for plant growth; the heavy inoculum having 6-8 billion bacteria per gram employs kaolin as a carrier. It is distributed to farmers for use with proper instruction to apply at a nominal cost. Roumanian, Bulgarian and Polish workers mentioned the increase in yield by the use of "phosphobacterin" up to 20-40% in many crops. Roumanian workers cautioned that

* Present address: Experimental Farm, Swift Current, Saskatchewan, Canada.

strains of *Bacillus megatherium* differed in their capability to produce effective inoculant and in their ability to mineralize the amount of phosphorus. These workers² did find 22° to 30° C. to be the optimum temperature for sporulation and that molasses was better than glucose as a source of carbohydrate. The recent reports by Smith, Allison and Soulides³ showed that the use of "phosphobacterin" as soil inoculant would be beneficial for vegetable crops. Where commercial fertilizers are available in abundance it would not be beneficial to accelerate the oxidation of soil organic matter in order to release phosphorus, but in India this situation is reversed and for this reason these bacteria may increase the amount of available phosphorus.

Silicobacteria alexendrov is used to produce "silicobacterin" which is used to increase the availability of potassium in soil. This bacteria is autotrophic and derives its energy from alumino-silicate of the soil. This organism was also isolated by Alexendrov in 1940.² The inoculation, having 40 million bacteria per gram, showed increases of 27—28% in exchangeable K.

There is also another bacterial inoculant known as "Lactobacterin" which is used to hasten the silage-making, and is produced from *Lactobacillus* spp. The use of "lactobacterin" decreased the spoilage of silage caused by moulds on the walls of silo and improved the palatability of silage.²

Use of bacteria in quick retting of fibres, production of mycorrhiza and mycelium of mushroom (*Psalliota compestris*) have shown encouraging results and in the very near future would be in manufacture stage. In increasing the efficiency of such inoculants the polyculture has proved more useful, mixed fertilizers brought about increase in yields of tomato, potato and other field crops.

The mechanism of the action of "bacterial fertilizers" is discussed in more detail by Cooper⁵, however, it is still a matter of speculation. Several hypotheses are put forward by Cooper,⁵ i.e., a provision of growth factors, destruction of soil toxins, acceleration of normal soil processes, stimulation of other microbes and antagonism towards other pathogens. All these hypotheses are plausible but there is a growing need to establish the validity of them. An application of 50 p.p.m. of gibrel (a potassium salt of gibberellic acid) increased the activity of autotrophes involved in sulfur oxidation and nitrification in 9 different Oregon soils.⁵ These results suggest that the "bacterial inoculants" may liberate substances which may increase the

efficiency as well as the number of the bacteria involved in such processes.

It can be said in summarization that after a tour of two months in the countries where "bacterial inoculants" are being used, the writer found a widespread faith in their ability to increase the yields of many crops. This confidence was exhibited by the farmers on the collective farms as well as the scientists engaged in their production and developments and agro-technologists who test their effectiveness in field trials and other research workers. However, some scientists were hesitant to go along with their "wonder effect" and described them only as supplemental to the mineral fertilizers. Whatever the pros and cons may be of their application, their popularity suggests a definite need of research on "bacterial inoculants", and their widespread use in communist countries should not be discarded as mere "political stunts", "lack of proper statistics", "faulty technique" and "poor experimentation", etc. The scientists with an "open mind" should explore this newly developed field which can bring benefits in a country where the commercial fertilizers are not readily available. Their application alone or in combination with mineral fertilizers, use of proper media for their maximum efficiency, the right strength of inoculation and the proper strains responsible for maximal activity should be emphasized and explored further.

ACKNOWLEDGEMENT

The author expresses thanks to the University of Baghdad for providing the facilities which made this tour possible through these countries. Further, grateful thanks are due to the interpreters without whose genuine help this tour could not have been useful. Also my thanks are due to my colleagues Drs. J. D. Beaton and K. F. Nielsen for the criticism and suggestions to improve the manuscript.

1. Allison, F. E., *Soil Sci.*, 1947, **64**, 413.
2. Anonymous, *Lucari Stiintifice (Report of the Bacterial Fertilizer Experimental Centre)* Ministry of Agriculture, Bucharest (Roumania), 1959.
3. Askinazi, D. L., *Soviet Soil Sci.* (English Trans.), 1958, **4**, 372.
4. Chandra, P. and Bollen, W. B., *Appl. Microbiol.*, 1960, **8**, 31.
5. Cooper, R., *Soils and Fertiliser*, 1959, **22**, 327.
6. Meiklejohn, J., *Trans. Sixth Int. Congr. Soil Sci.*, 1956, **3**, 243.
7. Menkina, R. A., *Mikrobiologiya*, 1950, **19**, 4.
8. Potkov, L., *A World We do not See*, Foreign Languages Pub., Moscow, 1957
9. Smith, J. H., Allison, F. E. and Soulides, T., *Soil Sci. Soc. Amer. Proc.*, 1961, **25**, 109.
10. Waksman, S. A., *Soil Microbiology*, John Wiley & Sons, New York, 1952.

CYTOGENETICS OF THE INTERGENERIC HYBRID, *VACCARIA GRANDIFLORA*
x *SAPONARIA VACCARIA*

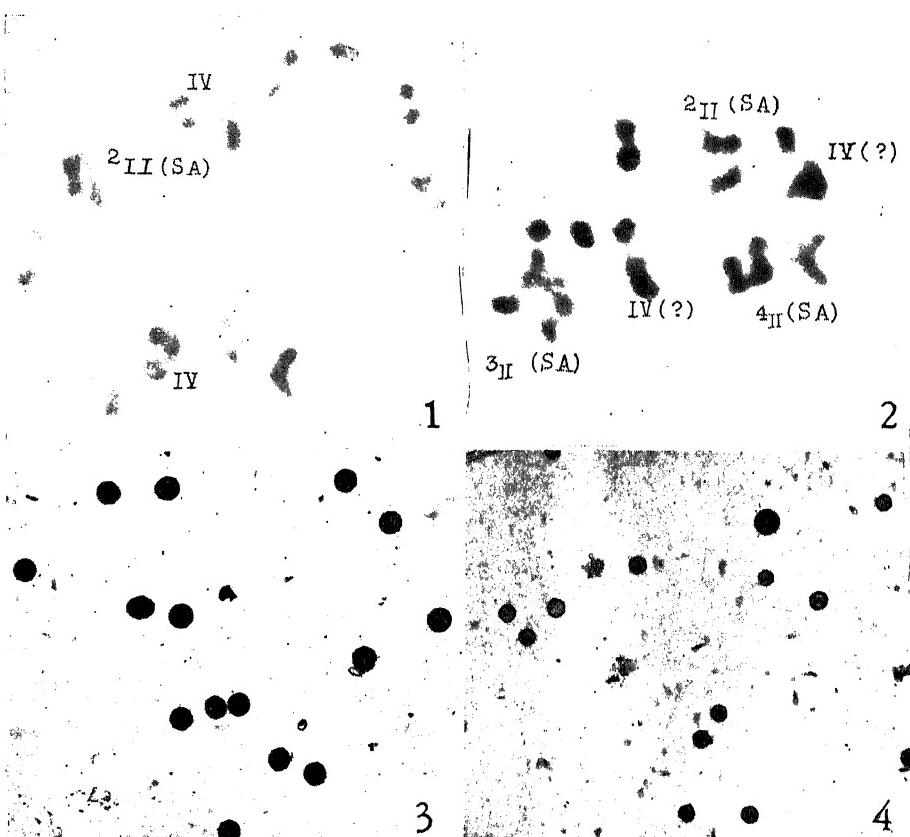
T. N. KHOSHOO AND S. K. BHATIA

Botany Department, Panjab University, Chandigarh-3

EXCEPT for Graminæ and Orchidaceæ, intergeneric hybridization in angiosperms is very rare. If such hybrids are fertile and involve plant species properly placed in two different genera, it is logical to conclude about their close genetic relationship and, as such, validity of one of these becomes questionable. Such a situation is aptly true of the present hybrid.

Saponaria vaccaria Linn. (Caryophyllaceæ) is a very common winter-annual weed of cultivation in the North-Western India and Khoshoo¹ found $n = 15$ in this. This finding raised a measure of suspicion about the biosystematic identity of the species, because all the other species of the genus *Saponaria* possess $n = 14$.^{2,3} In strong contrast to this, the species of the allied genus *Vaccaria*, possess exclusively $n = 15$.^{2,3} In order to unravel the genetic

relationships of *Saponaria vaccaria*, it was crossed extensively with members of the genera *Vaccaria* and *Saponaria*. While the details of these results, and implications thereof, of these experiments will appear elsewhere, it is of interest to report here on one of the hybrid combinations, *Vaccaria grandiflora* Jaub. and Spach. x *Saponaria vaccaria* Linn. Both these possess $2n = 30$ and $n = 15$. Karyotype in both is nearly similar and contains 6 sat-chromosomes. This fact fits very well with the earlier conclusion of Khoshoo¹ that the Silenoideæ with $n = 15$ are "cryptic polyploids", being at hexaploid level with $x = 5$. This is further confirmed by the presence of multivalent and secondary associations (Fig. 1). However, both the parents are perfectly fertile (Fig. 3). During meiosis the hybrid shows a reduced degree of multivalent formation but there is pronounced increase in



FIGS. 1-4. Figs. 1-2. Metaphase I in *Saponaria vaccaria* and F_1 *Vaccaria grandiflora* x *S. vaccaria*. Both possess $n = 15$ and show multivalents and secondary associations (S.A.), particularly in the latter, $\times 3,600$. Figs. 3-4. Pollen grains of *S. vaccaria* (94% stainable) and the F_1 (30%), $\times 100$.

secondary associations (Fig. 2). Possibly some of the secondary associations are disjoined multivalents. These features reveal that there is not only good deal of homology between the chromosomes of the two parents, but there also exists a measure of structural hybridity. The anaphases are perfectly clean but the fertility is reduced (30% in pollen, Fig. 4; and 37% in seeds), which indicates that disharmonious combinations are formed as a result of the recombination between the parental chromosomes. Possibly there is good deal of cryptic structural hybridity and we are attempting a detailed pachytene analysis to unravel the extent and nature of such hybridity.

The F_1 , F_2 and F_3 populations were raised and these are not only healthy and vigorous, but what is important, there is an increase in fertility from F_1 to F_3 (37 to 70% in seeds).

While *S. vaccaria* possesses no barriers to gene exchange at any stage when crossed with *V. grandiflora*, it, however, is strongly isolated genetically from other members of the genus *Saponaria* possessing $n=14$ (Fig. 5). This is

a critical morphological as well as chemical analyses of *S. vaccaria*. In all these features it resembles very closely the genus *Vaccaria*, rather than the genus *Saponaria*, a situation not accepted by Linnaeus.⁴

The genera *Vaccaria* and *Saponaria* as reconstituted now possess exclusively $n=15$ and $n=14$ respectively. Morphologically the former has inflated and 5-keeled calyx, non-appended petals and spherical seeds; while the latter has cylindrical and keelless calyx, appended petals and kidney-shaped seeds. Furthermore, *Vaccaria* contains traces of Saponin, while *Saponaria* possesses it in copious amount.

In view of the fertile hybrids and lack of barriers to gene exchange between the two parents, speciation between the reconstituted genus *Vaccaria* poses an interesting problem. The present investigations reveal that the two species (*i.e.*, *S. vaccaria* and *V. grandiflora*) are separated on somewhat minor taxonomic characters. A genetical analysis of F_2 and F_3 reveals that there is strong linkage between the characters separating the two species. Speaking evolutionarily there is a strong "coherence"⁵ between the taxonomic characters. The mode of inheritance of such characters is complex. It may be pointed out that it is such characters that are of real taxonomic value because in spite of hybridization they tend to segregate together. To put it simply, the more the coherence between the taxonomic differences, the more reliable and useful these are to the taxonomist.

In the end, it may be pointed out that this is an addition to the few examples of intergeneric hybrids in dicotyledons,⁶ where generic transfers have been made or are advocated on the basis of combined morphological, cytological and genetical study. Furthermore, such methods not only help in an understanding of the evolutionary processes, but also help in building classification which reflects the true evolutionary relationships of the taxa involved.

Our thanks are due to Prof. P. N. Mehra for facilities and Mr. Narinder Shah for help in making Fig. 5.

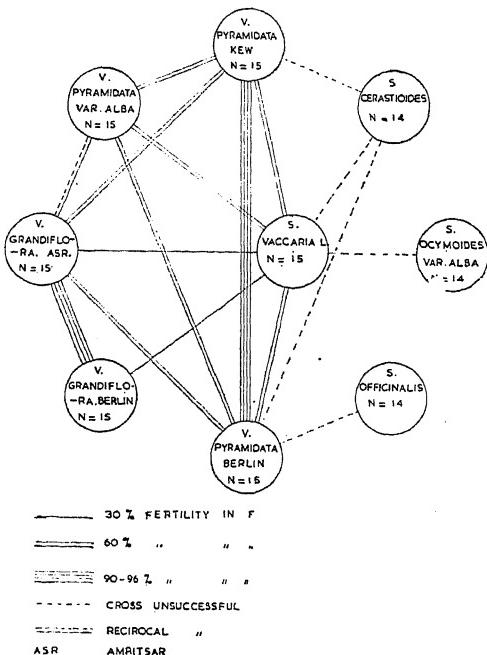


FIG. 5. Crossing polygon showing the genetic affinity of *Saponaria vaccaria*.

a very strong genetic proof for the fact that even though the name *S. vaccaria* Linn. is very commonly used in floras, monographs and research papers all over the world, in genetical sense it is actually a member of genus *Vaccaria*. This conclusion is further corroborated by

1. Khosloo, T. N., *Nature*, 1960, **186**, 412.
2. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, London, 1955.
3. Cave, M. S., et al., *Index to Plant Chromosome Numbers*, Calif. Bot. Soc. and Univ., North Carolina Press, 1956-59 and Supplement.
4. Linnaeus, C., *Species Plantarum*, Upsal., 1762.
5. Clausen, J. and Hiesey, W. M., *Proc. Nat. Acad. Sci. (U.S.A.)*, 1960, **46**, 494.
6. Rollins, R. C., *Chronica Botanica*, 1955, **14** (3), 133.

NOTE ON THE QUALITY OF GROUNDWATER FOR IRRIGATION IN THE SUBMONTANE TRACTS AND INTERMONTANE VALLEY OF UTTAR PRADESH

K. V. RAGHAVARAO AND T. S. RAJU

Exploratory Tubewells Organisation, Ministry of Food and Agriculture, Division IV, Roorkee

EXPLORATORY drilling operations were successfully carried out for the construction of heavy duty water wells for irrigation purposes in the year 1959-60 in the *Bhabar* formations of Nainital District and in the intermontane valley of Dehra Dun District (Doon Valley).

Geologically the *Bhabar* formations are constituted of unconsolidated sand-boulder and clay-boulder beds and the Doon alluvial fill is made up of clays, sands and gravels associated with boulders, cobbles and pebbles of limestone, and quartzite.

For the study under consideration, water samples have been obtained from the successfully completed wells, from water-bearing formations occasionally as deep as four hundred and fifty feet below land surface. The studies are based on the latest methods adopted by the U.S. Department of Agriculture, using the "Sodium Adsorption Ratio" or SAR for studying the suitability of water for irrigation.

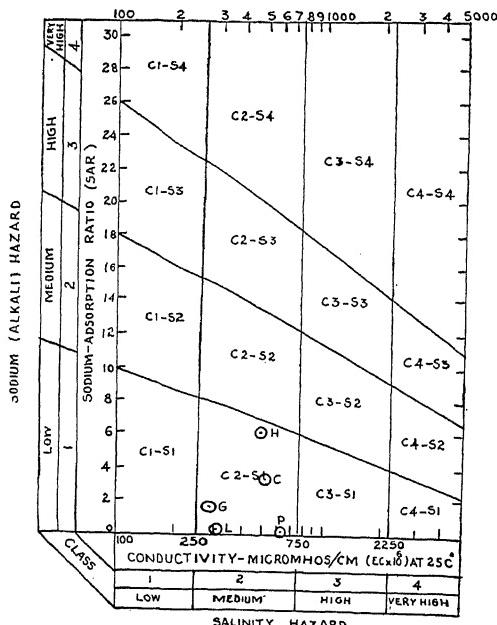


DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF IRRIGATION WATER.

○ G - GORAPARAV ○ L - LALKUA ○ C - CHANDINI
 ○ H - HIMMATPUR ○ P - PREMNAGAR
 R.P.S./10/61

In plotting the points on the diagram the specific conductance is taken as TDS and for irrigation use, termed as "Salinity Hazard". The

SAR values are computed from the analyses of well-waters and plotted on the vertical scale. Table I shows that water samples have been taken from set geological horizons.

From the locations of the points on the diagram (Class C2-S1), the following conclusions have been drawn:—

(1) Water wells located within the *Bhabar* and close to the foothills zone of the Himalayas, tap groundwater which is significantly low in salinity and sodium hazards and as such the water can be used on all soils and for most crops. The irrigation water from such wells, shows that the calcium and magnesium ions exceed sodium ions slightly. The waters are useful for maintaining good tilth and permeability of the soils.

(2) Though all the values of SAR are generally well below ten as indicated in the diagram, there is a tendency for the groundwaters close to the seepage or spring line zone (i.e., at the border of *Bhabar* and *Tarai*) to present a sodium hazard problem. Also the analyses indicate that sodium ions exceed the calcium and magnesium ions in quantity. In view of this, for any groundwater lift irrigation projects, the study of soils in this belt vis-a-vis chemical composition of groundwaters, may be desirable.

(3) The study of the usefulness of groundwaters, in the intermontane valley, for irrigation throws light on salinity hazard which needs study on the crop patterns. The high calcium content of the groundwater in the Doon Valley may be attributed to the geological setting of the valley, which borders the Krol limestone belt of Himalayas with its alluvial fill rich in gravels and pebbles of limestone. The soils are likely to be enriched in their permeability from the groundwaters, if applied for irrigational purposes. The sodium hazard is thereby minimised in this belt.

The studies are initiated for the first time in the submontane and intermontane tracts of Himalayas and bears significance in their future application to the entire *Bhabar* belt and intermontane valleys extending from Kashmir to Assam.

The authors wish to place on record their sincere thanks to Shri D. Mehta, Chief Engineer, E.T.O., New Delhi, and Shri M. P. Pandey, Executive Engineer, E.T.O., Roorkee, for the keen interest they have evinced in the work.

TABLE I
Analyses of water samples from geological zones at various depths

Sl. No.	Well	Geological horizon	Depth of the zone (in feet below land surface)	Electrical con- ductivity in micro- mhos/cm. at 25°C .	Chemical analysis (in parts per million)							
					Total dissolved solids	pH	Hardness as CaCO_3	Picarbonate HCO_3^-	Iron	Silica SiO_2	Calcium	
1	2	3	4	5	6	7	8	9	10	11	12	
District Nainital	Goraparav*	Bhabar (well placed in Bhabar)	350'-496'	278%	189	9.3	18.0	79.3	..	..	8.8
	Lalkua†	Bhabar ($2\frac{1}{2}$ miles N. of set page or spring line)	138'-148' 163'-203' 223'-253' & 268'-278'	302	205	7.5	163.0	186.0	Trace	25.6	20.4	
	Tanakpur*	Bhabar (well in Bhabar)	70'-90' 110'-212'	300	..	8.2	6.0	219.06	..	..	..
	Chandni*	Bhabar (close to the southern extremity of Bhabar)	67'-168'	515%	350	8.95	18.0	183.0	..	..	8.0
	Himmatpur*	Bhabar (close to the seepage or spring line)	142'-207'	480	325||	8.50	18.0	251.10	..	..	17.60
District Dehra Dun	Premnagar†	Doon alluvial fill	150'-170' 185'-225'	612	4.8	7.5	344.0	329.0	..	19.60	96.34	
	Forest Research Institute‡	do.	280'-340'	..	500	..	350.0	..	..	..	..

Chemical analysis (in parts per million)

Sl. No.	Well	Magnesium	Potassium	Sodium	Sulphate	Chloride	Sodium** adsorption ratio (SAR)	Calcium + Magnesium ($\text{Ca}^{++} + \text{Mg}^{++}$)	Sodium Ions (Na^+)	Remarks	
		13	14	15	16	17	18	19	20	21	
District Nainital	Goraparav*	..	17.76	2.6	35.6	18.4	8.0	1.589	1.8987	1.5486	$\text{Ca}^{++} + \text{Mg}^{++} > \text{Na}^+$
	Lalkua†	27	1.8	6.2	17.0	8.1	0.212	3.239	0.2397	..	$\text{Ca}^{++} + \text{Mg}^{++} > \text{Na}^+$
	Tanakpur*	..	..	..	..	Trace	20.0	..	..	..	Analysis incomplete
	Chandni*	..	26.0	1.27	90.00	Nil	20.0	3.467	2.5374	3.9150	$\text{Ca}^{++} + \text{Mg}^{++} < \text{Na}^+$
	Himmatpur*	..	2.40	5.04	104.0	29.8	15.0	6.169	1.0755	4.524	$\text{Ca}^{++} + \text{Mg}^{++} < \text{Na}^+$
District Dehra Dun	Premnagar†	..	25.2	1.0	6.69	79.0	11.3	0.157	6.880	0.2910	$\text{Cr}^{++} + \text{Mg}^{++} > \text{Na}^+$
	Forest Research Institute‡	..	..	..	..	..	..	..	..	..	Analysis incomplete

* Analysis carried out in the laboratories of Indian Agricultural Research Institute, New Delhi.

† Analysis carried out in the laboratories of the Geological Survey of India, Calcutta.

‡ Analysis furnished by the Forest Research Institute and Colleges, Dehra Dun.

Computed from the determined TDS value factor 0.678 derived from the chemical analysis of Lalkua water sample.

|| Computed from the determined electrical conductivity value and the factor 0.678 derived from the chemical analysis of Lalkua water sample.

$$\text{** SAR} = \sqrt{\frac{\text{Ca}^{++} + \text{Mg}^{++}}{2}}$$

LETTERS TO THE EDITOR

HIGH RESOLUTION PROTON
MAGNETIC RESONANCE SPECTRUM
OF COUMARIN

AN analysis of the nuclear magnetic resonance spectrum of a system containing 4 nuclei of the type ABCD (in the notation of Pople, Bernstein and Schneider¹) is quite complicated and does not seem to have been attempted so far except under certain approximations.

Such a system is encountered in coumarin molecule (Fig. 1) for the protons attached to the carbon atoms numbered 5, 6, 7, 8. The other two protons present in the molecule give rise to a spectrum of the AB type. Herein we report the proton resonance spectrum of coumarin which has been fully analysed both for ABCD and AB groups.

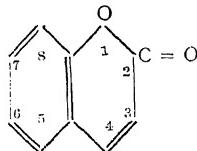


FIG. 1

The spectrum (Fig. 2) was recorded on a Varian associates' High Resolution Spectrometer operating at 60 Mc./s. The positions of various peaks were measured relative to cyclohexane as an internal standard with the usual side band technique. The resolution was of the order of 0.5 cps; the line separations could be measured with an accuracy of 0.5 cps. Solution of coumarin (100% pure Rhodia) was made in

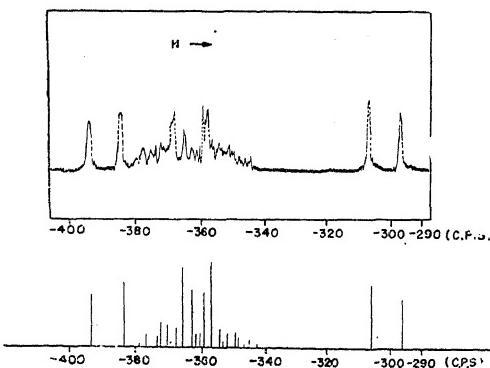


FIG. 2. Observed and calculated spectra of coumarin (frequencies are relative to cyclohexane as an internal standard).

tetrahydrofuran (E. Merck) and nitrogen gas was bubbled through it to remove any dissolved oxygen before using the sample for recording the spectrum. A spectrum of this molecule observed at 30 Mc./s. has been reported earlier²; however, the resolution achieved in the present case is far better and is, therefore, amenable for detailed analysis.

From the intensities and the line separations, the first two and the last two lines forming a quartet can be identified as arising from the protons attached to carbon atoms in positions 3 and 4. The first doublet from the left probably arises from the proton in 4 position as it is β to the carbonyl group and α to the phenyl group. The quartet was analysed on the AB theory and the following values have been obtained for the chemical shifts (δ) for the two protons (relative to cyclohexane) and the spin coupling constant (J_{34}).

$$\begin{aligned}\delta_3 &= -301.4 \text{ cps. } (-5.03 \text{ p.p.m.}) ; \\ \delta_4 &= -389.0 \text{ cps. } (-6.48 \text{ p.p.m.}) ; \\ J_{34} &= 9.8 \text{ cps.}\end{aligned}$$

The remaining lines in the spectrum have been ascribed to the protons of the ABCD type.

The secular equation for this system set up on the basis of the usual Hamiltonian :

$$H = \frac{1}{2\pi} \sum_i \gamma_i H_i I_z(i) + \sum_{i < j} J_{ij} I_i \cdot I_j$$

gets factorised into two 1×1 , two 4×4 and one 6×6 matrices. The eigenvalues and the orthonormalised eigenvectors corresponding to the 4×4 and 6×6 matrices were obtained using the T.I.F.R. digital computer, for different trial values of the parameters involved in the analysis. The following set of parameters gives the best fit between the calculated and the observed spectra. The theoretical spectrum is shown in Fig. 2 for comparison :

$$\begin{aligned}\delta_5 &= -368.9 \text{ cps. } (-6.15 \text{ p.p.m.}) ; \\ \delta_6 &= -354.0 \text{ cps. } (-5.90 \text{ p.p.m.}) ; \\ \delta_7 &= -367.8 \text{ cps. } (-6.13 \text{ p.p.m.}) ; \\ \delta_8 &= -352.6 \text{ cps. } (-5.88 \text{ p.p.m.}) ; \\ J_{56} &= 8.5 \text{ cps.} ; \\ J_{57} &= 2.0 \text{ cps.} ; \\ J_{58} &= 0 \text{ cps.} ; \\ J_{67} &= 8.6 \text{ cps.} ; \\ J_{68} &= 1.8 \text{ cps.} ; \\ J_{78} &= 8.5 \text{ cps.} .\end{aligned}$$

The details of the theoretical calculations of the analysis of ABCD type spectra will be

published elsewhere along with the analysis of the spectra of substituted coumarins; the results give interesting information regarding the resonance in coumarin, the nature of the double bond between carbon atoms in positions 3 and 4, and the effects of the substituents on the electron density at various carbon atoms in the ring.

The authors wish to thank Dr. R. Narasimhan and Sri. M. M. Dosabhai of the Computer Section of the Tata Institute of Fundamental Research for their help in running our matrices on the computer. They are also thankful to Professor S. S. Dharmatti for his constant encouragement and guidance during this investigation.

Tata Inst. of Fundamental Research, and Atomic Energy Establishment, C. L. Khetrapal, Trombay, Bombay,
July 8, 1961.

G. GOVIL.
C. R. KANEKAR.
Y. P. VIRMANI.

1. Pople, J. A., Schneider, W. G. and Bernstein, H. J., *High Resolution Nuclear Magnetic Resonance*, McGraw-Hill Publication, 1958, p. 98.
2. Dharmatti, S. S., Govil, G., Kanekar, C. R. and Virmani, Y. P., *Colloque De Pise*, 1960, p. 492.

POTENTIAL CONSTANTS OF CYCLOPROPANE AND CYCLOPROPANE- d_6

CYCLOPROPANE is a molecule belonging to the point group D_{3h} with the three carbon atoms lying in a plane and two H or D atoms attached to each one of the carbon atoms. The vibrational assignments have been proposed for the various fundamental frequencies by Lord and Baker.¹ Some of the fundamentals are inactive both in infra-red and Raman spectra. Estimated values were given for these with the help of overtones and the product rule.

The evaluation of the force constants for the vibrations (stretching, bending and twisting—in and out of plane) will enable us to fix up the inactive and unobserved frequencies with a fair degree of certainty. Using the A'_1 and A''_1 frequencies of an earlier assignment,² Saksena³ worked out a few potential constants by employing an approximate valence force field.

Using Wilson's F—G matrix method⁴ and a general valence force field, the force constants are now evaluated after setting up the F and G matrices for both the Cyclopropane and Cyclopropane- d_6 molecules. The following molecular data⁵ are employed for the calculations:

$$d(C-C) = 1.53 \text{ \AA}, r(C-H) = 1.09 \text{ \AA},$$

$\theta(H-C-H) = 116^\circ 56'$. The angle $\alpha(H-C-H)$ is calculated from the geometry of the molecule.

Table I lists all the numerical values for the force constants given in units of 10^5 dynes/cm. The angles are multiplied by \sqrt{rd} so that the internal co-ordinates are all of the same dimension of length.

TABLE I

	Cyclopropane	Cyclopropane- d_6
f_d	4.6534	4.2205
f_{dd}	-0.1115	0.0097
f_r	5.1706	5.2308
f_{rr}	0.0898	0.1260
f_{dr}	0.0722	0.1238
f_a	0.3154	0.3218
f''_{aa}	0.0809	0.0817
f'''_{aa}	0.0458	0.0529
$f^{'''}_{aa}$	0.1344	0.1342
f'_{da}	0.0231	0.0785
f'_{da}	0.0799	0.0965
f_{ra}	0.3718	0.2714
f_{ra}	-0.2664	-0.2335

f''_{aa} , f'''_{aa} , $f^{'''}_{aa}$ refer respectively to the interaction of two a 's having a common C—H bond, a common C—C bond and no common bond respectively. f_{da} , f'_{da} refer to d , a interactions having a common C—C bond and no common bond respectively. A similar notation for f_{ra} , f'_{ra} is followed.

The inactive fundamentals in A''_1 and A''_2 types as well as the CH_2 twisting frequency (which could not be directly observed) are calculated using the above data and are reported in Table II.

TABLE II

Vibration type	C_3H_6		C_3D_6	
	Calculated (cm. ⁻¹)	Estimated (cm. ⁻¹) (Baker and Lord)	Calculated (cm. ⁻¹)	Estimated (cm. ⁻¹) (Baker and Lord)
A''_1	693.1	975	489.1	790
A''_2	561.8	1125	475.0	800
E'	1210	1050	893	835
(CH_2 twisting frequency)				

Details will be published elsewhere.

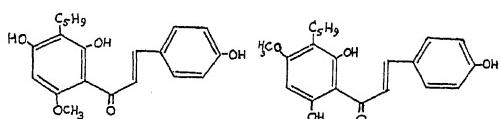
Department of Physics, P. BABU RAO.
S.V. University College, K. SREERAMA MURTY.
Tirupati, July 3, 1961.

1. Baker, A. W. and Lord, R. C., *J. Chem. Phys.*, 1955, **23**, 1636.
2. Herzberg, G., *Infra-red and Raman Spectra*, D. Van Nostrand Company Inc., New York, 1945.

3. Saksena, *Proc. Ind. Acad. Sci.*, 1939, **10A**, 449.
4. Wilson, E. B., Jr., *J. Chem. Phys.*, 1939, **7**, 1041; 1941, **9**, 76.
5. Pauling, L. and Brockway, L. O., *J. Am. Chem. Soc.*, 1937, **59**, 1223.
- Linnett, J. W., *J. Chem. Phys.*, 1938, **6**, 692.
- Dunitz, J. C. and Schomaker, *J. Chem. Phys.*, 1952, **20**, 1703.

CONSTITUTION OF XANTHOHUMOL

XANTHOHUMOL is a special type of chalkone isolated from hops resin by Verzele and co-workers.¹ They showed that it had the molecular formula $C_{21}H_{22}O_5$, one methoxyl and three hydroxyl groups and a dimethyl allyl group and proposed structure (I) for it. Vandewalle and Verzele² provided confirmatory evidence. Later Hubner *et al.*³ considered that the alternative structure (II) would be the correct one. The cause of this disagreement is due to the difference in the behaviour of the two analogous ketones, 2 : 4 : 6-trihydroxy-1-isobutyryl 3-methyl benzene and 2 : 4 : 6-trihydroxy-1-acetyl 3-(3-methylbut-2-enyl) benzene towards diazomethane. The former yields the 4-methyl ether and the latter the 6-methyl ether. The matter has been clarified in the recent paper of Vandewalle and Verzele⁴ who have provided more evidence in favour of structure (I). A point that could be mentioned in further support of their structure is as follows. So far no stable chalkone has been found to occur in nature having two free hydroxyl groups in the 2' : 6' positions. Experiments have shown that this structure is unstable (see Narasimhachari and Seshadri⁵). Since Xanthohumol is a fairly stable chalkone comparable with butein (Seshadri),⁶ it should have the methoxyl in one of the above two positions. Of the two, the 6-position, is the only possibility.



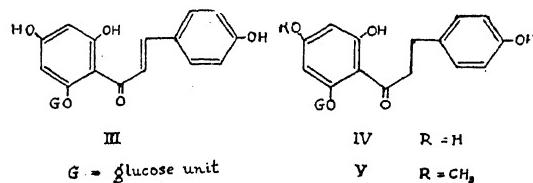
I

II

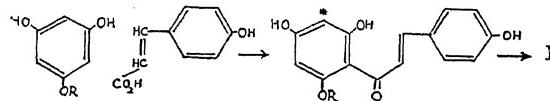
Xanthohumol is extraordinary among the natural chalkones in having a methoxyl in the 6-position and an isoprene unit in the 3-position. Somewhat analogous will be the occurrence of 6-glucosidoxy chalkone, isosalipurposide (III) and the 6-glucosidoxy dihydrochalkones, phloridzin (IV) and asebotin (V).

A discussion of the evolution of these glucosides has been given earlier⁷⁻⁸ and the considerations hold good even for the 6-methoxy compounds. Probably the most satisfactory suggestion will

be the combination of a phloroglucinol methyl ether or glucoside as the C_6 unit with cinnamic acid derivative as the C_9 unit. Then the chalkone will be stable enough to occur free and



the newly entering C_5 unit can get in only in the 3-position which is the active nuclear position in the hydroxy ketone structure for nuclear alkylation (see for collected literature Jain and Seshadri).⁹ The stages are indicated below:



R = CH_3 or glucose unit

Chemistry Department, M. R. PARTHASARATHY,
Delhi University, T. R. SESADRI,
Delhi-6, July 5, 1961.

1. Verzele, M., Stockx, J., Fontijn, F. and Anteunis, M., *Bull. Soc. Chim. belges.*, 1957, **66**, 452.
2. Vandewalle, M. and Verzele, M., *Ibid.*, 1959, **68**, 711.
3. Hubner, H. and Riedl, W., *Ber.*, 1960, **93**, 312.
4. Vandewalle, M. and Verzele, M., *J.C.S.*, 1961, 1021.
5. Narasimhachari, N. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1948, **27A**, 223 and subsequent papers.
6. Seshadri, T. R., *Scientific Proceedings, Royal Dublin Society*, 1956, **27**, 77.
7. —, *Proc. Ind. Acad. Sci.*, 1950, **32 A**, 372.
8. —, *Ann. Review of Biochem.*, 1951, **20**, 508.
9. Jain, A. C. and Seshadri, T. R., *Jour. Sci. Ind. Res.*, 1955, **14 A**, 231.

SOME REACTIONS OF EMBELIN

AN earlier note¹ deals with the isolation and constitution of vilangin, as methylene-bis (2 : 5-dihydroxy-4-undecyl-3 : 6-benzoquinone) and its synthesis accomplished by condensing embelin (III) with formaldehyde. This reaction is capable of further extension and embelin could be expected to condense with various aldehydes. Kaul *et al.*² have studied these condensations in some detail at a time when the constitution of embelin and its synthesis were not known. Several aldehydes have now been condensed

with embelin to give compounds of vilangin type (I) and anhydrovilangin type (II), and these condensation products were designated by us as analogues of vilangin and anhydrovilangin respectively.

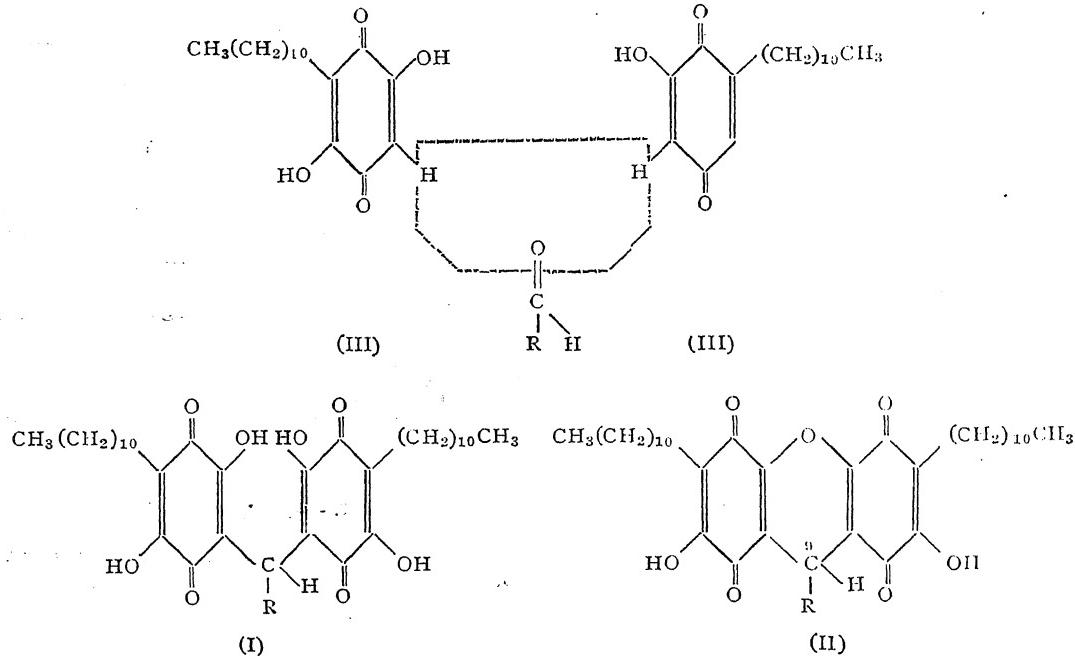


TABLE I

Aldehyde	Product	Colour
Formaldehyde	Vilangin	Orange yellow
Acetaldehyde	(a) Methylvilangin (b) 9-Methylanhydrovilangin	Pale orange Orange red
Propionic aldehyde	(a) Ethylvilangin (b) 9-Ethylanhydrovilangin	Pale grey Orange red
Benzaldehyde	(a) Phenylvilangin (b) 9-Phenylanhydrovilangin	Orange yellow Orange do.
Phenylacetaldehyde	9-Benzylanhdrovilangin	Golden yellow
Cinnamic aldehyde	9(β-Phenylvinyl) anhydrovilangin	Scarlet red
β-Dimethylamino benzaldehyde	9(4'-Dimethylaminophenyl)anhydrovilangin	Orange
β-Hydroxy benzaldehyde	9(4'-Hydroxyphenyl) anhydrovilangin	Orange red
β-Methoxy benzaldehyde	9(4'-Methoxyphenyl) anhydrovilangin	Scarlet
Salicylaldehyde	9(2'-Hydroxyphenyl) anhydrovilangin	Deep orange
Ortho-methoxy benzaldehyde	9(2'-Methoxyphenyl) anhydrovilangin	Deep purple
3 : 5-Dinitrobenzaldehyde	9(3' : 5'-Dinitrophenyl) anhydrovilangin	Orange red
3 : 4-Methylenedioxy benzaldehyde	9(3' : 4'-Methylenedioxyphenyl) anhydrovilangin	do.
Vanillin	9(3'-Methoxy-4'-hydroxyphenyl) anhydrovilangin	Orange yellow
Veratraldehyde	9(3' : 4'-Dimethoxyphenyl) anhydrovilangin	Orange yellow

Table I gives a summary of the aldehydes used for this condensation and the nature of the products obtained thereof.

From a study of the data presented, the following conclusions could be drawn. While with formaldehyde, only one product, vilangin, was obtained with acetic, propionic and benzaldehydes, both the vilangin and anhydrovilangin

to note that no condensation took place with aliphatic and aromatic ketones.

Fuller details would be published elsewhere.

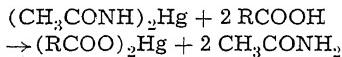
Dept. of Chem., V. VENKATESWARLU.
Andhra University, CH. BHEEMASANKARA RAO.
May 17, 1961.

1. Bheemasankara Rao, Ch., and Venkateswarlu, V., *Curr. Sci.*, 1961, **30**, 259.
2. Kaul, R., Ray, A. C. and Dutt, S., *J. Ind. Chem. Soc.*, 1931, **8**, 231.

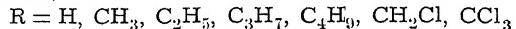
MERCURATION OF COMPOUNDS CONTAINING REACTIVE METHYLENE GROUP BY MEANS OF MERCURIC SALTS OF ORGANIC ACIDS

NAIK AND SHAH,^{1,3} Naik and Patel² mercurated ethyl acetoacetate, diethyl malonate and their substituted amides, by using mercuric chloride, mercuric acetate and mercury acetamide. But it appeared from references to literature that different mercuric salts, derived from substituted and unsubstituted organic acids, have not been systematically utilised for mercuration of compounds containing reactive methylene group. In the present investigation mercury formate, acetate, propionate, butyrate, isovalerate (isopropylacetate), monochloracetate, trichloracetate have been used to mercurate ethyl acetoacetate.

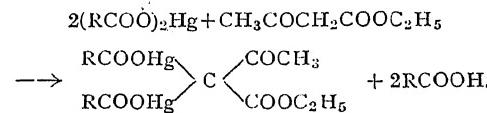
The mercury salts required for mercuration of ethyl acetoacetate have been prepared by a new method involving the interaction of mercury acetamide with appropriate acids.



In the above equation and in the equations that follow,



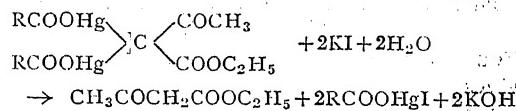
The mercurated products of ethyl acetoacetate have been prepared by treating the ester with mercury salts in aqueous solution maintaining continuous stirring.



The characteristic properties of these compounds are given in Table I.

On passing slowly H₂S gas into a hot alcoholic suspension of the substance a black precipitate of HgS was quantitatively obtained.

The influence of different acidic groups attached to mercury on the stability of C-Hg bond has been determined by interacting the mercurated products with alcoholic potassium iodide and estimating the amount of alkali liberated in specific time. The reaction involved therein is as under :—



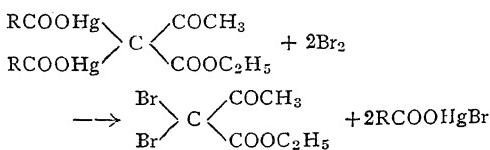
It is found that the C-Hg bond becomes weaker as we pass from acetoxy through propoxy to butyroxy. On the other hand C-Hg bond becomes relatively stable when C-Hg bond in isopropylacetoxy-group is present. The monochloracetoxy and trichloracetoxy groups bring about the weakening of C-Hg bond.

TABLE I

Sl. No.	Name	Formula	Colour change	Decomposition temperature	Analysis	
					Found	Calculated
1	Ethyl diformyloxy mercury acetoacetate	C ₈ H ₁₀ O ₇ Hg ₂	White-grey (due to liberation of mercury)	..	Decomposes in presence of light	Hg 64.75%
*2	Ethyl diacetoxy mercury acetoacetate	C ₁₀ H ₁₄ O ₇ Hg ₂	White to yellow to brown	245° C.	Hg 61.9	Hg 61.97%
3	Ethyl dipropioxy mercury acetoacetate	C ₁₂ H ₁₈ O ₇ Hg ₂	do.	225° C.	Hg 59.22	Hg 59.41%
4	Ethyl dibutyroxy mercury acetoacetate	C ₁₄ H ₂₂ O ₇ Hg ₂	do.	210° C.	Hg 57.46	Hg 57.05%
5	Ethyl di(isopropylacetoxy) mercury acetoacetate	C ₁₆ H ₂₆ O ₇ Hg ₂	do.	195° C.	Hg 54.68	Hg 54.87%
6	Ethyl dimonochloracetoxy mercury acetoacetate	C ₁₀ H ₁₂ Cl ₂ O ₇ Hg ₂	Light yellow to brown	214° C.	Hg 55.82	Hg 56.02%
7	Ethyl ditrichloracetoxy mercury acetoacetate	C ₁₀ H ₈ Cl ₆ O ₇ Hg ₂	Light yellow to brownish black	210° C. (swelling)	Hg 46.72	Hg 46.96%

* This compound was prepared by Naik and Patel.²

On treatment with bromine in chloroform all the compounds gave the same α , α dibromoethyl acetoacetate as under :—



It is observed that C-Hg bond is readily ruptured with bromine in all the mercurated products.

Birla Vishvakarma Mahavidyalaya, K. S. PATEL,
Vallabh Vidyanagar,
(Via Anand), and
Chemistry Department, B. N. MANKAD.
Sardar Vallabhbhai Vidyapeeth,
Vallabh Vidyanagar.
(Via Anand).

1. Naik and Shah, *J. Ind. Chem. Soc.*, 1930, 7, 655.
 2. — and Patel, *Ibid.*, 1932, 9, 185.
 3. — and Shah, *Ibid.*, 1931, 8, 29.

ESTIMATION OF SELENIUM WITH THIOUREA

YOE AND OVERHOLSER¹ stated that selenous acid gives a red precipitate on treatment with a saturated solution of thiourea. This reaction is utilised in the gravimetric estimation of selenium, which offers a distinct operational advantage over the usual sulphur dioxide precipitation.²

Full details of the estimation are given as follows:

About 0.1 gm. of pure selenium is accurately weighed and dissolved in 2 ml. of concentrated nitric acid. The solution is evaporated to dryness. The solid thus obtained is dissolved in about 25 ml. of water to which two or three drops of hydrochloric acid are added. The clear solution of selenous acid is treated with saturated solution of thiourea in excess. A red precipitate of selenium is formed immediately. The precipitate is kept for about two hours at room temperature and heated to boiling with vigorous stirring till the red selenium coagulates to a greyish-black button, and the supernatant liquid becomes clear. Then it is filtered hot through a weighed sintered glass crucible. The element is successively washed first with hot water, then with absolute alcohol and then dried in electric oven at 110° C. for about an hour, cooled in a desiccator and weighed as free element.

The results are tabulated in Table I.

This indicates that quantitative estimation is possible for selenium with thiourea. The

TABLE I
Precipitation of Se by Thiourea

No.	Wt. of Se taken (gm.)	Wt. of Se found (gm.)	Error (gm.)
1	0.0498	0.0500	+ 0.0002
2	0.0641	0.0640	- 0.0001
3	0.1333	0.1332	- 0.0001
4	0.1540	0.1541	+ 0.0001
5	0.1818	0.1816	- 0.0002

accuracy of our results was of the same order as that by the sulphur dioxide method.³

Dept. of Chem., A. SITARAMACHANDRAMURTHY.
Karnatak Univ., M. S. CHANDRASEKHARIAH.
Dharwar, June 19, 1961.

1. John, H. Yoe and Lyle, G. Overholser, *Ind. Eng. Chem., Anal. Ed.*, 1942, **14** (5), 435.
 2. Keller, *J.A.C.S.*, 1897, **19**, 771.
 3. James, F. Reed, *Anal. Chem.*, 1960, **32** (6), 662.

INFLUENCE OF ADSORBENT ON THE FORMATION OF LIESEGANG RINGS

VARIOUS theories have been proposed from time to time to explain the Liesegang phenomenon. They are based on the results of certain set of periodic reactions. Attempts have been made by some workers to study the influence of foreign substances like sugar,¹ alcohol,² powdered glass,³ on the Liesegang rings. Hughes,⁴ Lincoln and Hillyer,⁵ Fricke and Suzelack⁶ have postulated from their results that supersaturation does not exist during ring formation of silver chromate in gelatin gel, copper chromate in silicic acid gel, magnesium hydroxide in agar gel. But their conclusions are based upon the analysis of one constitutional ion, and neither is there the analysis of clear spaces after ring formation or involving any calculation.

In the present case investigation is carried out on the influence of adsorbents [e.g., precipitated silica (B.D.H.) and thoroughly washed, dried precipitates of the same substance that forms the periodic structures] on the formation of rhythmic bands of silver chromate in an agar gel medium. The usual procedure of producing Liesegang rings is adopted except that certain quantity of silica and washed, dried precipitate are mixed with suitable quantity of 2% agar sol containing the reagent and allowed to set to gel. These experiments are conducted for seven hours at 8°C. Work on the quantitative aspect has shown close agreement between the values of d obtained on the basis of geometric progression equation and the values actually observed. The influence of adsorbent is expressed in terms

of the spacing coefficient (b) between the two successive rings, and is given by the equation $d = bn^2$, where d is the distance travelled by the diffusion front of each band from the starting point, and n the number of rings formed from the commencement of diffusion. The curve in Fig. 1 shows the analysis of precipitate front

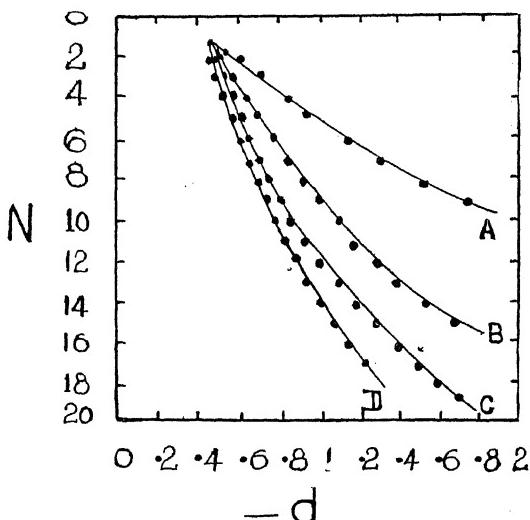


FIG. 1. A—Diffusion in gel only. B—Diffusion in gel containing 0.200 gm. of silica. C—Diffusion in gel containing 0.500 gm. of silica. D—Diffusion in gel containing 0.900 gm. of silica.

after diffusion of 1N silver nitrate into an agar gel containing $N/10$ potassium chromate. The steepness of the curve increases with the increase in the concentration of adsorbent. The uniformly distributed particles of the adsorbent act as centres for the condensation of the reactants, and due to their bulk density and porosity influence on the rate of flow of the liquids depending upon the space taken up by the adsorbent in the gel. Table I shows the value of spacing coefficients obtained at different concentrations of the adsorbent.

TABLE I

Sl. No.	Amount of Adsorbent	Spacing Coefficient
1	gel only	0.00514
2	0.200 gm.	0.00113
3	0.500 gm.	0.000407
4	0.900 gm.	0.000393

The diminution in the value of b with the increase in the concentration of the adsorbent is related to the fact that the particles of the adsorbent act as centres for the condensation of

the molecules of the reactants with the subsequent relief of supersaturation earlier than under normal condition, resulting lesser spacing between the two successive rings. Bradford and his coworkers² have mentioned that the ring formation is the consequence of the adsorption of the solute from the gel. But it is obvious from the present observations of low value of b at higher concentration of the adsorbent, that the supersaturation is more influencing than adsorption in ring formation. Besides, the sparingly soluble substance forms relatively stable and highly supersaturated product. The ultramicroscopic observation has confirmed that the product of reaction is produced in a truly soluble and diffusible form, but not as a colloidal solution.⁸ Similar results are obtained using precipitate as adsorbent. Experiments are also conducted on the rhythmicity of Lead iodide and Lead chromate respectively.

The author wishes to express his sincere gratitude to Dr. K. Krishnamurti, for his suggestions and helpful criticism during this work; and to the Director, Geology and Mining Department, for permission to communicate this article for publication.

Chemical Laboratories, B. V. DHARESHWAR,
Mining and Geology Department,
Temple Road, Civil Lines,
Nagpur-1, March 21, 1961.

1. Alfred Koenig, *J. Phys. Chem.*, 1920, **24**, 46.
2. A van Hook, *Ibid.*, 1938, **42**, 1191.
3. Don R. Manley and Kurt, Stern, H., *J. Colloid Science*, 1955, **10**, 404.
4. Hughes, *Biochem. J.*, 1937, **28**, 1086; *Kolloid Z.*, 1931, **71**, 100; 1955, **72**, 216.
5. Lincoln and Hillyer, *J. Physic. Chem.*, 1936, **40**, 645.
6. Fricke and Suzelack, *Z. Physic. Chemistry*, 1926, **124**, 359.
7. Bradford, J., *Biochem. Z.*, 1916, **10**, 109; 1917, **11**, 14.
8. Dhar and Chatterjee, *J. Phys. Chem.*, 1924, **28**, 41; *Kolloid Z.*, 1922, **31**, 15; 1925, **37**, 80.

ESTIMATION OF GALACTURONIC ACID BY PAPER CHROMATOGRAPHY

DURING the course of our investigations on the mucopolysaccharides of blackgram (*Phaseolus radiatus*) it was observed that it contained very small quantities of galacturonic acid which could not be estimated directly by the colorimetric method of Dische.^{1,2} The high viscosity of the polysaccharide solution was an additional difficulty. A chromatographic method is described here which can be used for estimating small quantities of galacturonic acid in polysaccharides of similar materials.

In initial experiments to estimate galacturonic acid by paper chromatography very high paper blanks were obtained. Washing with water or 2 N hydrochloric acid followed by water washings were found to reduce the paper blanks from an initial value of 50 to 6. Washed Whatman No. 1 papers were, therefore, used in further work. The following is a brief description of the method used for estimation.

The hydrolysate of the polysaccharide was spotted on the treated paper (23×20 cm.) and chromatograms were developed by the ascending technique using butanol : acetic acid : water (4 : 1 : 5) and phenol : water (2 : 1) systems.^{3,4} The phenol system contained a small amount of ammonia and sodium cyanide. Good separations were achieved by allowing chromatograms to overrun for 24 hours with the first solvent and using filter-paper circles to assist the solvent flow.⁵ The phenol run was usually for 6-7 hours. After allowing the paper to dry overnight, it was sprayed with benzidine trichloroacetic acid.⁶ The acid could also be located under ultra-violet light. The spots were cut out, eluted by three successive extractions with 5 ml. water for half hour and after centrifuging, the combined eluates were evaporated to dryness over a water-bath. The residue was taken up with 1 ml. water and the galacturonic acid estimated colorimetrically according to Dische.² Standard galacturonic acid at various dilutions was also spotted and estimated as above after chromatography.

Glucuronic acid by itself did not develop any colour under these conditions. When superimposed on the galacturonic acid it did not also enhance the colour readings (Fig. 1). The standard curve relating the colour readings to the galacturonic acid concentration followed a straight line course. Recovery of acid added to the polysaccharide hydrolysate was also good (94-98%) (Table I). 20-50 μ g of galacturonic acid in the polysaccharide could be estimated by the method.

TABLE I

% Recovery of added galacturonic acid

Hydrolysate in ml.	Standard galacturonic acid added in μ g.	Optical density $\times 500$ at 540 m μ	Recovery %
0.08	..	35	..
..	80	84	..
0.08	80	117	97.5
..	160	170	
0.08	160	192	93.75

The polysaccharide was hydrolysed by refluxing 20 mg. of the substance with 2 ml. of 2 N HCl in a boiling water-bath for 3 hours. The values are averages of four replicates and are corrected for the blanks.

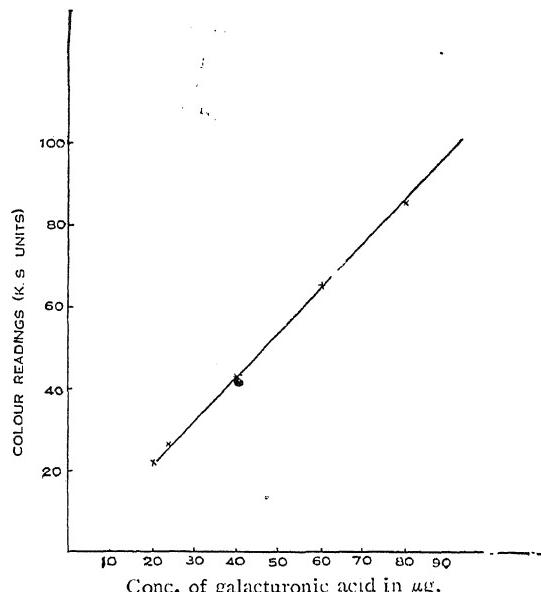


FIG. 1. Estimation of galacturonic acid by the Dische method after chromatography.

● Represents colour reading when 40 μ g glucuronic acid was superimposed on the galacturonic acid.

The authors' thanks are due to Dr. V. Subrahmanyam and Dr. M. Srinivasan for their kind interest in the work.

C.F.T.R.I.,
Mysore, March 1961.

S. B. KADKOL.
H. S. R. DESIKACHAR.

1. Dische, Z., *Arch. Biochem.*, 1948, **16**, 409.
2. —, *J. Biol. Chem.*, 1950, **183**, 489.
3. Partridge, S. M., *Biochem. J.*, 1948, **42**, 238.
4. Radhakrishnamurthy, R. and Sarma, P. S., *Curr. Sci.*, 1954, **23**, 266.
5. — and —, *J. Sci. Industr. Res. (India)*, 1952, **11B**, 279.
6. Bacon, J. S. D. and Edleman, J., *Biochem. J.*, 1951, **48**, 114.

OCCURRENCE OF AMINO-ACIDS AND ALLIIN IN THE INDIAN ALLIUMS (GARLICS)

ALLIUM species or garlics are commonly used as an article of food and condiment. Preparations of garlic have been used in medicine for a wide variety of ailments.^{1,2} In recent years a crystalline principle alliin, a precursor of the antibacterial principle allicin, has been isolated^{2,3} from *A. ursinum* and *A. sativum* and pharmaceutical products containing allicin are available in the market. A detailed work on the amino-acid composition of onion and garlic has been reported previously by Parthasarathy and Sastry.⁵ However, knowledge about the amino-acids in the other less-known Indian Alliums

is very meagre. Except for the work of Rao et al.,⁶ no work regarding occurrence of alliin in other Indian Alliums is reported so far. The purpose of the present study was to determine the amino-acid composition of Indian Alliums and also to screen these species for the presence of alliin.

Allium sativum and *A. cepa* were procured from the local market, *A. ampeloprasum* from Mussoorie, red variety bulbs and bulbils of *A. sativum* and a triploid *Allium species*⁷ available under the name of 'Pran' from Kashmir, *A. rubellum* from Pathankot and one unidentified species from Lloyd Botanical Garden, Darjeeling. For amino-acid determination, 5 g. of the fresh material was homogenized with 10 ml. of 75% alcohol and 25 λ of the clear filtrate of each of the variety was subjected to paper chromatography using butanol : acetic acid : water (4 : 1 : 5) and phenol : isopropanol : water (14 : 1 : 5) as solvent systems. The amino-acids were identified by their Rf. values in the above two solvents, by their colour with ninhydrin and alloxan⁸ and finally by comparing their movements with those of reference amino-acids on paper chromatograms. A rough idea about the relative amount of each amino-acid was obtained by observing the intensity and size of the coloured spots on chromatograms. The results are shown in Table I.

yellowish-brown spot with ninhydrin (Rf. 0.27 in butanol, acetic acid, water and 0.68 in phenol, isopropanol, water), and as little as 0.006 γ of alliin could be detected on paper chromatograms. However, no spot of alliin could be discovered in the chromatograms originally run for detection of amino-acids. When whole bulbs were stabilized by immersion in boiling water for 5 minutes, prior to extraction and chromatography, in order to destroy the enzyme alliinase,⁹ alliin could be detected in *A. sativum* (red and white varieties), *A. ampeloprasum* and *A. species* (pran). It was totally absent in all other varieties investigated including the bulbils of *A. sativum*.

A method for semi-quantitative determination of alliin was developed in which use was made of the observation that the size of spot of alliin on chromatograms was generally proportional to the amount of alliin present. Similarly if a number of spots were applied, each representing the same amount of alliin, the size of spots produced after development of chromatogram was consistently identical.

5 g. of stabilized bulb was homogenised in a waring blender with 10 ml. of 70% ethanol, filtered, and volume of the filtrate was again adjusted to 10 ml. by addition of 70% ethanol. With a micropipette 25 λ of this extract was applied on a sheet of Whatman No. 1 chromatographic paper. On the starting line of the same

TABLE I
Amino-acid composition of various species of Allium

Amino-acid	Species							
	<i>A. ampeloprasum</i>	<i>A. sativum</i> local	<i>A. sativum</i> white	<i>A. rubellum</i>	<i>A. species</i> (Pran)	<i>A. sativum</i> (Bulbils)	<i>A. cepa</i>	Unidentified <i>A. species</i>
Alanine	++	+++	+++	++	+++	++
Arginine	+++	+++	+++	Absent	++	+++
Aspartic acid	++	+	++	++	Tr.	Tr.
Asparagine	+	++	+	++	+	Tr.
Histidine	+	Tr.	+	Tr.	Absent	Tr.
Leucine	+	++	++	++	+	++
Methionine	+++	+++	+++	+	++	+
Phenyl-alanine	++	++	+	Absent	Absent	Absent
Proline	Tr.	+	+	Absent	Tr.	Tr.
Serine	++	+	++	++	++	+
Threonine	++	Tr.	+	++	++	Tr.
Tryptophan	+++	++	+++	Tr.	Absent	+
Valine	++	++	++	++	Absent	Tr.
Unidentified amino-acid	2	2	1

Tr. = traces; +, ++, +++, indicating relative amounts of amino-acids.

According to Stoll² alliin gives a positive colour reaction with ninhydrin and alloxan. It was found by the authors that alliin gives a

sheet of paper 5 more spots representing 10, 20, 30, 40, 50 λ of an alliin solution (5 mg./c.c.) were applied, representing 0.05, 0.1, 0.15, 0.2

and 0.25γ of pure alliin. After the development of the chromatogram the size of alliin spot given by the garlic extract was compared with the size of spot produced by the known graded quantities of pure alliin. This comparison gives a rough idea of amount of alliin present in 25λ of the garlic extract and the percentage of alliin could be calculated from the results thus obtained. *A. sativum* (Kashmir red), *A. sativum* (local white), *A. ampeloprasum* and *A. species* (pran) contained approximately 1.0%, 0.8%, 0.4% and traces of alliin respectively.

Thus, it has been shown that red variety of *A. sativum* is the richest source of alliin and that alliin is also present in significant amount in the hitherto uninvestigated *A. ampeloprasum*.

Our thanks are due to Dr. T. N. Khoshoo for help in providing authentic samples and to the Director, Research, Sandoz Ltd., Basle, Switzerland, for the supply of alliin sample.

Pharmacognosy Section,
Department of Pharmacy,
Punjab University,
Chandigarh-3, May 29, 1961.

C. K. ATAL
J. K. SETHI

7. Khoshoo, T. N., Atal, C. K. and Sharma, V., *Panjab Univ. Res. Bull.*, 1960, **11**, 37.
8. Saifer, A. and Oreskes, I., *Annal. Chem.*, 1956, **28**, 501.
9. Pruthi, J., Singh, L. and Lal, G., *Curr. Sci.*, 1959, **28**, 403.

HARDBOARDS FROM *LANTANA*

At the request of the Maharashtra State Forest Department the suitability of *Lantana* for hardboard manufacture was investigated. The material was supplied by the Range Forest Officer, Chikalda Range, Amravati Circle. According to the Conservator of Forests, Amravati Circle, about 25,000 tons/year of the material are available.

In the earlier experiments the material in the form of chips was cooked at atmospheric pressure with alkali and defibrated in a Condux mill. As the material is hard the results were not very satisfactory. So in later experiments the material was subjected to a prehydrolysis with water alone, defibrated and again cooked with mild alkali. The pulp was subjected to the usual procedure and pressed at 200 lb./sq. inch at 160°C . for 30 minutes (3/16" thickness of the board). The cooking conditions and results of strength and other tests are given in Table I.

As can be seen from Table I from strength point of view satisfactory boards have been obtained under all conditions. With prehydrolysis the results are very good. However,

TABLE I
Properties of hardboards from *Lantana* twigs

No.	Alkali and concentration	Solid : liquid ratio	Time of cooking hrs.	Pulp recovery %	Ordinary board				Tempered board			
					Density g./cm. ³	M.C. %	Modulus of rupture Kg./cm. ²	Moist. % absorption in 24 hrs.	Treatment	M.C. %	Modulus of rupture Kg./cm. ²	Moist. % absorption in 24 hrs.
1	Lime 1.5%	.. 1 : 4	3	62	1.02	8.9 (271)	174.8	(b)	7.9	378	74.8	
2	Lime 2.5%	.. 1 : 5	3	61	1.01	15.3 (232)	142	(c)	..	341	65.2	
3	NaOH 0.5%	.. 1 : 5	2½	63	1.01	10.4 (254)	162	(a)	7.9	144	100	
4	NaOH 0.75%	.. 1 : 5	2½	62	1.04	11.3 (207)	150	(b)	7.5	238	81	
5	NaOH 0.75% .. (after preboiling with water for one hr.)	1 : 5	1½	60	1.05	5.2 383	152	(c)	5.8	258	75	
								(a)	12.2	152	97	
								(b)	8.8	262	101	
								(c)	7.8	294	60	
								(a)	8.5	277	79	
								(b)	5.8	319	70	
								(c)	7.5	460	71	
								(a)	6.4	468	59	

Note.—Treatments: (a) Added 3% rosin to pulp; (b) Tempered at 180°C . for 2 hours; (c) Tempered at 180°C . with C.N.S.L. for 2 hours.

the moisture absorption is rather high. This has to be improved. It will be useful to examine whether this material can be mixed with hard woods for board manufacture.

Forest Research Inst., D. NARAYANAMURTI.
Dehra Dun, R. C. KOHLI.
May 22, 1961.

DISCOVERY OF OSTRACODA AND SMALLER FORAMINIFERA FROM THE UPPER CRETACEOUS BAGH BEDS, M.P.

A rich and varied assemblage of Ostracoda and Microforaminifera has recently been discovered by the writer from the Deola Marl stage of the Bagh formations of M.P. Although larger invertebrate fossils were recorded from these beds as early as 1857, little attention seems to have been paid to microfossils. The only paper within the author's knowledge dealing with foraminifera from these beds is by Singh (1950).

The writer has identified 22 species of ostracodes from the Deola Marls. These include 10 new species. A check-list is given below:

Paracypris sahnii n.sp., *P. jonesi* (Bonnema), *P. monmouthensis* (Schmidt), *P. gracilis* (Bosquet), *P. limburgensis* (Veen), *Bairdia misrai* n.sp., *B. obliqua* (Alexander), *Bythocypris chiplonkeri* n.sp., *B. goodlandensis* (Alexander), *Macrocypris?baghensis* n.sp., *?Macrocypris graysonensis* (Alexander), *Cythereis* sp. aff., *C. krummensis* (Alexander), *Cytherura thuatiensis* n.sp., *Haplocythereidea?punctura* (Schmidt), *Monoceratina tewarii* n.sp., *Monoceratina* sp. indet., *?Paracypridea obovata* (Swain), *Cytherella contracta* (Veen), *Cytherelloidea indica* n.sp., *C. subgranulosa* n.sp., *C. raoi* n.sp., *Brachycythere bhatiae* n.sp.

A brief diagnosis of the new species described is given below :

Paracypris sahnii JAIN, N.S.P.

Carapace compressed, elongate in side view; dorsal margin angulate anteriorly and posteriorly; the middle portion between the two angulations longest and straight; anterior margin obliquely rounded, posterior acuminate; greatest height anterior; left valve slightly larger and overlapping ventrally; surface smooth.

Bairdia misrai JAIN, N.S.P.

Carapace compressed, elongate in side view, sub-triangular in outline; dorsal margin arched, ventral margin convex; anterior margin narrowly rounded, posterior produced into a sub-acute beak; greatest height just behind the middle; left valve larger and slightly overlapping.

Bythocypris chiplonkeri JAIN, N.S.P.

Carapace elongate, reniform, highly inflated when viewed dorsally; dorsal margin evenly arched, ventral straight; anterior margin broadly and posterior narrowly rounded; greatest height and width lies in the middle; width slightly greater than the height; surface closely pitted.

Macrocypris? baghensis JAIN, N.S.P.

Carapace elongate, smooth, highest at the anterior angulation just in front of the middle, from where the dorsal margin tends to become straight; ventral margin very nearly straight; posterior margin produced and pointed in the middle; the hinge of the right valve consists of a groove which starts just below the anterior angulation and runs up to nearly half the length of the valve, followed by a bar; the other elements of the hinge—two serrate ridges and a posterior groove—are indistinct.

Brachycythere bhatiae JAIN, N.S.P.

Carapace elongate, highly inflated ventrally, sub-triangular in side view; dorsum arched, venter straight; greatest height at the anterior angulation just in front of the middle; anterior margin broadly rounded, posterior pointed below; when viewed dorsally the ends are compressed and pointed; hinge hemiamphidont.

Cytherura thuatiensis JAIN, N.S.P.

Carapace sub-rectangular in outline, elongate, smooth; dorsal margin convex, ventral margin keeled, straight and with a prominent ridge; anterior side broadly rounded, posterior drawn out dorsally into a caudal process; anterior margin rounded as seen in the dorsal view, posterior compressed and pointed; greatest height anterior.

Monoceratina tewarii JAIN, N.S.P.

Carapace elongate, sub-quadratae; anterior margin broadly rounded and rimmed; the ventral ridge with a large posterior spine and three subsidiary nodes, the posterior being the weakest; two more nodes are present on the anterior and posterior ridges.

Cytherelloidea indica JAIN, N.S.P.

In both the valves a ridge starts from the antero-dorsal margin which runs continuously throughout the ventral and posterior margins, then bends below the antero-dorsal margin just below its commencement, and then forms a loop.

Cytherelloidea subgranulosa JAIN, N.S.P.

The carapace with a discontinuous rim on the anterior and posterior margins; two nodes are present on the posterior shoulder; a discontinuous ridge starts from the upper node below

the dorsal rim, another ridge is present just above the ventral rim; surface with a number of small tubercles which are largely confined to the middle part of the carapace.

Cytherelloidea raoi JAIN, n.sp.

Carapace with a marginal rim on the dorsal and posterior margins; a rib starts from the postero-dorsal tubercle just below the anterior rim, and runs for the greater length of the carapace, and curves round the muscle pit.

Besides the Ostracodes the writer has identified the following foraminiferal genera:

Quinqueloculina, *Triloculina*, *Discorbis*, *Cibicides*, *Neobuliminina*, *Lenticulina*, *Planularia*, *Frondicularia*, *Nodosaria*, *Marginulina*, *Palmitia*, *Globigerina* and *Globorotalia*.

Ophuroid ossicles, echinoid spines and dwarf and juvenile forms of gastropods, lamellibranchs and brachiopods are also very common in the Bagh material.

The author is deeply indebted to Prof. M. R. Sahni of Panjab University for the kind perusal of the manuscript and to Dr. S. B. Bhatia of Panjab University for the help received during the course of the present work.

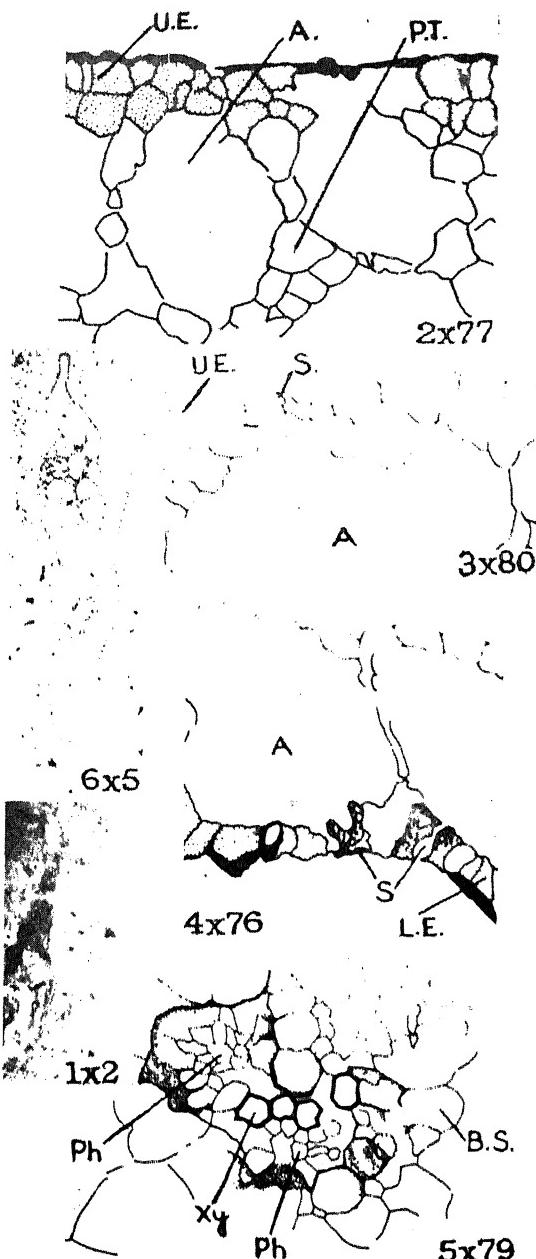
Department of Geology, S. P. JAIN,
Panjab University,
Chandigarh-3, August 3, 1961.

1. Carter, H. J., *Jour. Bob. Br. Roy. As. Soc.*, 1857, 5, 614.
2. Howe, H. V. and Laurence, Laura, *An Introduction to the Study of the Cretaceous Ostracoda*, Louisiana State University Press, 1958.
3. Singh, S. N., *Curr. Sci.*, 1950, 19, 174.

PETRIFIED MONOCOTYLEDONOUS LEAVES FROM THE TERTIARY OF MADHYA PRADESH

THE two petrified monocotyledonous leaves described here were collected by the author in the year 1953 from the Deccan Intertrappean Beds near Mohgaon-kalan village of Chhindwara district. The geological age of these beds has already been determined as tertiary (Eocene).

The leaves are preserved in the reddish-brown and brownish black cherts, which occur abundantly in these beds. For studying their anatomy, several peel sections were taken with the help of the author's improved technique.¹ Such leaves have not so far been reported from these beds, the known forms being dicotyledonous leaves in the form of impressions and petrifactions^{2,3} from the different localities of Chhindwara district. These have been obtained from the different cherts and may be called leaf A and leaf B for the sake of convenience.



FIGS. 1-6. Fig. 1. T.S. leaf A. Fig. 2. T.S. leaf A showing upper epidermis (U.E.), air chambers (A) and partition wall (P.T.). Fig. 3. T.S. leaf A showing upper epidermis (U.E.), vestigial stoma (S) and air-chambers (A). Fig. 4. T.S. leaf A showing lower epidermis (L.E.), stomata (S) and air-chambers (A). Fig. 5. A single V.B. of leaf A showing bundle sheath (B.S.), xylem (XY) and phloem (Ph). Fig. 6. T.S. leaf B.

Leaf A.—This is more or less completely preserved, preservation being very good. However, its two margins have not come in the peel sections. It measures 8×3.3 mm. in cross-section. The general appearance is spongy. The surfaces of the leaf are slightly wavy. The epidermis is a thin naked layer; cuticle is lacking (Fig. 1).

The upper epidermis is double layered (Fig. 2). At places vestigeal stomata-like structures are visible (Fig. 3).

Numerous air-chambers of varying sizes are present below the epidermal layers. These are separated from each other by 1-celled partition walls of irregular parenchymatous cells.

The lower epidermal cells are smaller in size than the cells of the upper epidermis but are all pentagonal in shape. Air-chambers of the ventral surface probably open by means of stomatal openings (Fig. 4).

The vascular bundles are many and scattered throughout the body of the leaf. Nearly ten vascular bundles of monocotyledonous type have, however, been traced in the peel section. The bundles are enclosed in a parenchymatous bundle sheath (Fig. 5). The bundle sheath resembles the endodermis but is weakly developed.² It was not possible to find chloroplast and casparyan strips in the cells of the sheath. These cells are in close association with the conducting elements of the vascular bundle on their inner faces and with the spongy mesophyll and epidermis on the outer face. Morphologically these cells are a part of mesophyll.

There is a considerable reduction in the vascular bundles which is a remarkable feature of aquatic angiosperms. The xylem elements are surrounded by phloem cells. It is worthwhile mentioning here that in some of the smaller bundles, the xylem vessels are completely absent. The phloem cells are many as compared with the xylem vessels of the vascular bundles.

Leaf B.—The partial preservation of this leaf does not furnish enough details for studying its anatomy. It measures 11×2 mm. in cross-section (Fig. 6). It resembles the leaf A in having air-chambers and in being spongy in nature. The surfaces are wavy and the presence of considerable amount of aerenchyma tissue provides a good amount of buoyancy to the leaf. The air-cavities are prominent and scattered internally throughout the leaf. The epidermal cells are small, walls of the air-cavities are multi-layered and parenchymatous.

I take this opportunity for expressing my sincere thanks to Dr. M. R. Sahni, of the Punjab

University, for his valuable suggestions and for going through the manuscript.

Tilak Dhari College,
Jaunpur (U.P.).

J. N. DWIVEDI.

1. Dwivedi, J. N., *Science and Culture*, 1959, **24**, 481.
2. Eames, A. J. and Mac Daniels, L. M., *An Introduction to Plant Anatomy*, 1947, 328.
3. Sahni, B., *Curr. Sci.*, 1934, **3**, 134.
4. Shukla, V. B., "Palaeobotany in India-VII," Reprinted from *J. Indian bot. Soc.*, 1950, **20** (i), 29.
5. Trivedi, T. (Mrs.), *J. Palaeontological Soc.*, 1956, **1** (i), 186.

A NEW SPECIES OF PEYRONELLAEA GOID

GOIDANICH¹ created this genus in 1946 to accommodate some members of Sphaeropsidales which possessed ostiolate pycnidia like those of *Phoma* or *Phyllosticta* but their chlamydospores (Hypnoscysts) resembled the dictyospores found in hyphal dematiaceæ such as *Alternaria* or *Coniothecium*, etc.

In March 1958 the authors observed a serious leafspot disease on the plants of *Eriobotryæ japonica* at Naini Agricultural Institute, Allahabad. The infection was mostly either marginal or from the tips and developed brown lesions on the leaf-blade. Occasionally few scattered spots were also observed. Isolations from most of the diseased regions yielded an *Alternaria*-like fungus in culture. About a month later few ostiolate pycnidia were also formed in those cultures. On account of this peculiarity the organism was sent to Commonwealth Mycological Institute, Kew, where it was identified to be a species of *Peyronellæa*. Detailed investigations established that cultures derived from single pycnidiospores produced dark brown pycnidia as well as multiseptate muriform chlamydospores, while the culture plants seeded with chlamydospores alone developed pycnidia also in 6-7 days. The development of pycnidia was considerably increased if maltose was one of the ingredients of the culture medium. A spray with spore suspension produced typical symptoms on the host in 4-6 days but the chlamydospores required about 10 days for causing the infection.

Morphological characters of this species were not in complete agreement with any of those Sphaeropsidales² which have been transferred to this genus or with any other species referable to genus *Peyronellæa*.^{3,4} Due to obvious differences in its habitat as well as in the size of chlamydospores, pycnidia and pycnidiospores, this species is described as *Peyronellæa*

nainiensis, sp. nov. having the following characters:

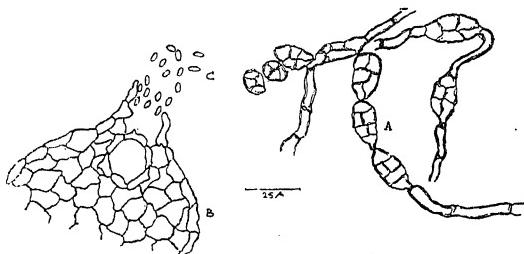


FIG. 1. *Peyronellaea nainiensis*. A. Chlamydospores ; B. A portion of pycnidium ; C. Spores.

Peyronellaea nainiensis, sp. nov.—Chlamydospores abundant, intercalary, usually in chains, variable in shape and size, light-brown, resemble the conidia of *Alternaria tenuis*. Number of septa varies from 1-6, usually three transverse septa and one or two longitudinal septa, $13-46.8 \times 9.1-16.9 \mu$. Pycnidia dark-brown or black, generally spherical or slightly oval, $80-135 \times 73-121 \mu$ prominently ostiolate, conidia numerous, hyaline, ellipsoidal $3.2-5.3 \times 1.9-2.6 \mu$.

Latin translation

Peyronellaea nainiensis spec. nov.—Chlamydospores abundantes, intercalares, vulgo catenatae, formae et magnitudinis variabilis, pallide brunneae, similes conidiis *Alternarie tenuis*. Septa numero variabili, 1-6, vulgo 3 transversa, unum vel duo longitudinalia, $13-46.8 \times 9.1-16.9 \mu$. Pycnidia fusce brunnea vel nigra, vulgo sphaerica vel paulum ovalida, $80-135 \times 72-121 \mu$, eminenter ostiolata. Conidia plurima, hyalina et ellipsoidea, $3.2-5.3 \times 1.9-2.6 \mu$. In foliis *Eriobotryae japonicae*.

The authors are grateful to Dr. J. C. F. Hopkins, Director, C.M.I., Kew, for his assistance in identification of the fungus and to Prof. H. Santapau, for the Latin translation.

Botany Department, R. N. TANDON.
Univ. of Allahabad (India), K. S. BILGRAMI.
April 4, 1961.

1. Goidanich, G., *R.C. Acad. Lincei.*, 1946, 3, 449.
2. —, *Ibid.*, 1946, 5, 654.
3. Lacoste, L., *C.R. Acad. Sci., Paris*, 1955, 13, 818.
4. Togliani, F., *Ann. Sper. Agr.*, N.S., 1952, 6, 81.

RUMINATE ENDOSPERM IN THE CANELLACEAE

THE phenomenon of endosperm rumination has been reported in about 29 families of dicotyledons, one in monocotyledons and one in gymnosperms (Periasamy, 1959). The occurrence of this peculiar morphological character is proving to be of immense value in problems concerning taxonomy and phylogeny as has been pointed out by Corner (1949, 1951).

During the course of a comparative morphological study of the Canellaceæ, the author had the opportunity to examine the seeds of several genera of the family. The endemic genus *Cinamosma* from Madagascar with its two species, *C. madagascariensis* (Herb. No. Pret. 2712/43. 58 and 2713/43. 58) and *C. macrocarpa* (Herb. No. 5088/Pret. 2716/43. 58, Type specimen) obtained through the courtesy of the Director, National Museum, Paris, showed the presence of rumination. The rumination processes are rather mildly developed in *C. macrocarpa* and more pronouncedly in *C. madagascariensis* (Figs. 1, 2). In the



FIGS. 1-3. Fig. 1. *Cinamosma macrocarpa*. Part of the seedcoat showing ruminate processes, $\times 160$. Fig. 2. *Cinamosma madagascariensis*. Longisection of seed showing ruminate seedcoat, $\times 52$. Fig. 3. *Cinamosma madagascariensis*. A rumination process enlarged from Fig. 2, $\times 100$.

absence of complete developmental stages it is difficult to ascertain the individual share of the outer and inner integuments in the building of the rumination processes, although a careful examination of the available stages suggests that at least one or two layers of the inner integument line the interior of the processes. The outer integument which consists of several cell layers with numerous oil cells constitutes the major bulk of the rumination process (Fig. 3). The rumination process is devoid of any vasculature. This may prove to be of diagnostic value in the light of the vascularized rumination processes of *Myristica fragrans*, *Actinophlaeus ambiguus*, *Areca catechu*, *Caryota furfurata*, etc.

It may also be noted here that the seeds of *Cinnamosma* differ from those of other genera (*Canella*, *Cinnamodendron*, *Warburgia*, *Capsicodendron* and *Pleodendron*) not only by the possession of ruminate processes but also by the absence of a sclerosed outer epidermal layer of the outer integument. Thus the ruminating seed-coat of *Cinnamosma* is wholly parenchymatous. Although Netolitzky (1926) has figured such a structural feature in the seedcoat of *Cinnamosma* he has not reported the occurrence of rumination.

I am deeply indebted to Prof. B. G. L. Swamy for kind encouragement and criticism.

Department of Botany, N. PARAMESWARAN.
Presidency College.
Madras-5, July 21, 1961.

1. Corner, E. J. H., *New Phytol.*, 1949, **48**, 332.
2. —, *Phytomorphology*, 1951, **1**, 117.
3. Netolitzky, F., *Anatomie der Angiospermensamen*, Berlin, 1926.
4. Periasamy, K., *Ph.D. Thesis*, Madras Univ., 1959.

NEW RECORDS OF MICROFUNGI FROM USAR-SOILS OF INDIA

DURING the study of soil "microflora" of Usar (alkaline)-soils of Uttar Pradesh, India, a large number of microfungi and bacteria have been isolated. For the purpose of this study Usar-soils, with varying pH between 7.1 and 11.5 were randomly selected from Lucknow, its neighbourhood and few other districts of U.P.

So far about 125 species of fungi have been isolated from nearly 600 soil samples that have been investigated during the period September 1957 to December 1960. The relative percentage of species of each class of fungi occurring in these soils is as follows:

Phycomycetes 20%, Ascomycetes 16%, Basidiomycetes 0% (nil), Deuteromycetes (Fungi Imperfecti) 64%.

A scrutiny of the available literature showed the following 17 forms to be either new records from soils or from Indian soils and the list is given in Table I, along with the pH-range of the soils, from which they were isolated.

TABLE I

Sl. No.	Fungi	pH-range
1	* <i>Absidia repens</i> van Tiegh.	7.1-10.0
2	* <i>Circinella umbellata</i> van Tiegh. & Le Mon.	7.2-8.2
3	* <i>Mucor bacilliformis</i> Hess.	7.1-8.5
4	* <i>Mucor genevensis</i> Lend.	7.1-8.5
5	* <i>Zygorhynchus heterogamous</i> Vuill.	7.1-8.2
6	* <i>Blakeslea trispora</i> Thax.	7.1-8.2
7	* <i>Arachniotus citrinus</i> Massee & Sal.	7.1-7.3
8	* <i>Chetomium eristatum</i> Ames.	7.1-10.5
9	† <i>Ascotricha guamensis</i> Ames.	7.1-9.0
10	† <i>Gelasinospora</i> sp. nov.	7.1-9.5
11	† <i>Tripterospora</i> sp. nov.	7.2-10.2
12	* <i>Sporonema spinula</i> Kalch.	8.2-10.5
13	* <i>Fusidium terricola</i> Miller et al.	8.0-8.2
14	* <i>Penicillium aurantiacum</i> Miller et al.	7.1-8.0
15	* <i>Spicaria violacea</i> Abbott.	7.1-9.2
16	* <i>Papularia sphaerosperma</i> (Pers.) vön. Hon.	7.1-8.5
17	† <i>Graphium</i> sp.	7.1-8.5

* First report from Indian soils;

† First report from soils.

In addition to the forms described above several other species of fungi have been isolated from these soils. These, although they have been reported earlier, are of rare occurrence, and include *Choanephora conjuncta* Couch; *Circinella muscae* (Sor.) Berl. and de Toni; *Thielavia setosa* Dade; *Pyrenophaeta decipiens* March.; *Aspergillus carneus* (v. Tiegh.) Bloch.; *Nigrospora sphærica* (Sacc.) Mason; *Heterosporium allii* Ellis and Mart.; *Colletotrichum falcatum* Went; *Colletotrichum dematium* (Pers. Ex. Fr.) Grove and *Epicoccum nigrum* Link.

The authors wish to express their gratitude to Prof. Roy F. Cain for his valuable suggestions, and to the Director, Commonwealth Mycological Institute, Kew (England), for confirming the identifications of few of the forms.

Microbiology Laboratory, J. N. RAI.
Botany Department, K. G. MUKERJI.
Lucknow University,
Lucknow, January 28, 1961.

A LEAF DISTORTING VIRUS DISEASE OF *JATROPHA CURCAS* LINN.

Jatropha curcas Linn. is grown in this region as a field barrier by the cultivators. Serious disease symptoms were observed on a large number of *Jatropha curcas* plants in various localities of Indore during the rainy season of

1957. The symptoms consisted of marked reduction in the leaf size, rolling of leaf margins upwards and prominent puckering of the leaf surface. Chlorotic areas of irregular shape were present on the lamina near the margin and in between the main veins (Fig. 1). There were minute but distinct enations along the veins on the under-surface of many leaves.



FIG. 1

TRANSMISSION TESTS

Plants raised from seeds collected from diseased plants during the previous season remained healthy showing thereby that the disease is not transmissible through seed.

Two to three weeks old healthy and vigorously growing plants raised under insect proof conditions from seeds were inoculated with the juice of diseased leaves in the usual way using carborundum powder as an abrasive. None of the inoculated plants developed disease symptoms indicating that the disease is not transmissible by sap inoculation.

Shoots from infected *Jatropha curcas* plants were cleft grafted on healthy *Jatropha curcas* plants. The grafts were covered individually by muslin bags which were kept wet to provide humid conditions necessary for the organic union between the stock and the scion. This method worked well and when new shoots developed on the stocks they developed typical symptoms of the disease (Fig. 2) showing that the disease is transmissible by grafting, thus confirming its viral nature.

As certain plant viruses have been found transmissible to healthy plants through dodder (*Cuscuta* sp.)^{1,2} and as the virus under report

is not transmissible by sap inoculation, attempts were made to transmit the disease by the agency of dodder, but without success.



FIG. 2

Transmission tests with the tobacco leaf curl virus vector, the white fly (*Bemisia tabaci* Gen.)³ also gave negative results.

HOST RANGE TESTS

The disease could not be transmitted to any other plant except *Jatropha curcas*. Attempts made to transmit it by grafting to *Nicotiana tabacum* L., *Lycopersicum esculentum* Mill., *Solanum melongena* L. and *Datura stramonium* L. were not successful.

The symptoms of the disease described resemble to some extent those produced by the tobacco leaf curl virus on certain of its hosts,⁴ but whereas the latter is transmitted by white flies the virus causing disease in *Jatropha curcas* is not transmissible by these insects. Moreover, chlorosis which is so prominent in the case of the disease on *Jatropha* is not common on plants attacked by the tobacco leaf curl virus. The virus causing the disease in *Jatropha curcas* should, therefore, be considered as distinct.

I am grateful to Dr. W. V. Bhagwat, Principal, for providing facilities for work.

Department of Botany,
Holkar College, Indore,
December 12, 1960.

R. P. GARGA.

1. Johnson, F., *Phytopathology*, 1941, **31**, 649.
2. Kunkel, L. O., *Ibid.*, 1952, **42**, 27.
3. Pruthi, H. S. and Samuel, C. K., *Indian J. Agric. Sci.*, 1939, **9**, 223.
4. Smith, K. M., *A Text Book of Plant Virus Diseases*, Second Edition, J. and A. Churchill Ltd., London, 1957.

**A POLYHAPLOID PLANT OF
SORGHUM HALEPENSE (L.) PERS.**

THOUGH the production of plant species by means of chromosome doubling is now recognized as a common phenomenon, the reverse process of reduction in chromosome number, such as the occurrence of haploids from diploids by parthenogenesis, is still a rare and uncontrolled phenomenon. The significance of polyhaploids as tools for experimental research in cytogenetics and genetics as well as for breeding has been amply demonstrated in other crops such as corn¹ and cotton.² The origin and nature of ploidy in *S. halepense* ($2n=40$) is still a matter of considerable controversy. Some workers³ are of the opinion that it could be an autotetraploid and others⁴⁻⁶ believe it to be an allotetraploid. While others⁷ consider it to be a segmental allotriploid or that it could be a quantitative polyploid.⁸

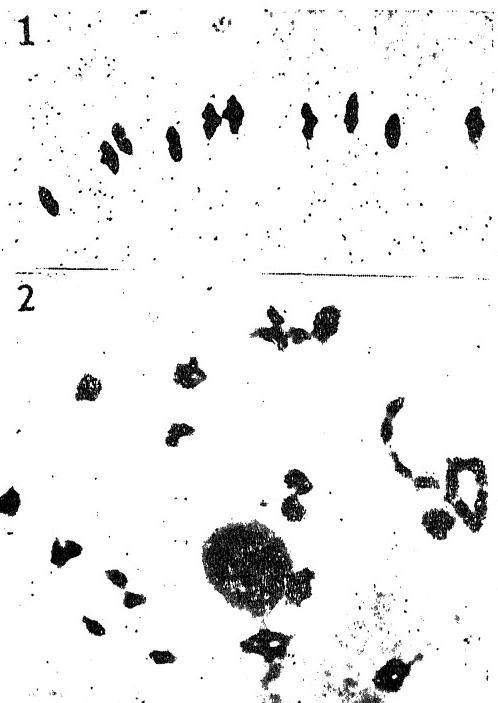
The present paper reports the occurrence of a polyhaploid plant in the F_1 population of a cross between *S. halepense* (Sub-section *Halepensia*) $2n=40$ ♀ and *S. verticilliflorum* (Sub-section *Arundinacea*) $2n=20$ ♀. About 20 florets were emasculated in *S. halepense* and pollinated with the pollen of *S. verticilliflorum* under controlled conditions. The four seeds obtained from this cross were sown in pots in the green-house, along with the parents but only one germinated. Even this single plant did not exhibit any of the characters of the male parent but resembled the female parent in almost all its characters. It was first suspected that it may be the result of accidental selfing. However, cytological examination showed that this plant contained only 20 chromosomes in its somatic cells suggesting that it might, presumably, have arisen by haploid parthenogenesis. Since species with $n=10$ are known in this genus, this plant with $2n=20$ must be considered to be polyhaploid.

During the early stages of growth this plant showed slower growth than the tetraploid *S. halepense*. At maturity, however, the tetraploids were not taller or more vigorous than this plant, the polyhaploid had fewer tillers and broader leaves than the tetraploid parents and flowered later. Though the number and length of nodes of the panicle were about the same, the polyhaploid bore a large number of branches at the lower nodes than the $4n$ plants. The polyhaploid plant was thick culmed and had a very poorly developed rhizome. The pollen fertility ranged from 70 to 75% as compared to 74 to 80% in the tetraploids (Table I).

TABLE I
Comparative study of certain morphological characters and pollen sterility between polyhaploid plant and tetraploid plants

Characters	Polyhaploid ($2n=20$)	Tetraploid ($2n=40$)
Height of plant (cm.)	190	170-230
Number of tillers	26	40-85
Width of leaves (cm.)	1.8-2.3	1.3-2.0
Number of panicle branches	26-48	21-48
Pollen fertility	70-75	74-80

Ten bivalents were normally present at diakinesis and metaphase I in the polyhaploid plant (Fig. 1). However, in 6% of the micro-



FIGS. 1-2. Fig. 1. Polyhaploid *S. halepense* ($2n=20$). Metaphase I, with 10_n ($\times 1,550$). Fig. 2. *S. halepense* ($2n=40$). Diakinesis, with $2_{IV} + 15_n + 2_I$ ($\times 1,550$)

sporocytes $9_n + 2_I$ were also observed. A low degree of meiotic irregularity was found in the later stages and may, perhaps, account for part of the observed pollen sterility. On the other hand, tetraploid *S. halepense* showed bivalents and quadrivalents (Fig. 2). The range of quadrivalents being 2 to 5 at diakinesis and 0 to 4 at metaphase I, with rare occurrence of tri- and univalents. The average value of chromosome configurations (mean of 20 cells) observed at diakinesis and metaphase I were

$2.67_{IV} + 0.13_{III} + 14.4_{II} + 0.16_I$, and $1.80_{IV} + 0.05_{III} + 14.55_{II} + 3.55_I$, respectively.

Studies on the synapsis of chromosomes at pachytene in the polyhaploid, preliminary though they are, have revealed the presence of minute, yet cytologically detectable, structural differences like duplication and non-pairing terminal regions. From this it is easy to discern the wealth of information that could be obtained from a cytological study of hybrids from the polyhaploid and natural diploids as well as those from the artificially doubled polyhaploid and natural tetraploids. This will bring to bear on the complex problem of interrelationship amongst *halopeplense* genomes, a more complete delineation. Such studies are in progress.

The authors are grateful to Dr. B. P. Pal and Dr. A. B. Joshi for their advice and keen interest. We are also thankful to Dr. M. S. Swaminathan for helpful comments.

Division of Botany, M. L. MAGOON.
Indian Agric. Res. Inst., K. G. SHAMBULINGAPPA.
New Delhi, M. S. RAMANNA.
May 18, 1961.

1. Randolph, L. F. and Fischer, H. E., *P.N.A.S.*, 1929, **25**, 161.
2. Meyer, J. R., *Rec. Genetics Soc. Amer.*, 1954, **23**, 55.

3. Longley, A. E., *J. Agric. Res.*, 1912, **44**, 313.
4. Karper, R. E. and Chisholm, A. T., *Amer. J. Bot.*, 1936, **23**, 369.
5. Huskins, C. L. and Smith, S. G., *J. Genet.*, 1932, **25**, 241.
6. Garber, E. D., *Amer. Nat.*, 1944, **78**, 89.
7. Duara, B. N. and Stebbins, G. L., *Genetics*, 1952, **37**, 369.
8. Krishnaswamy, N., *Indian J. Genet.*, 1951, **11**, 67.

SOME LEAFSPOT DISEASES

DURING the year 1959-60, the authors isolated about six dozen fungi responsible for various leafspot diseases at Allahabad and its neighbourhood. In the present list only those leafspot diseases are included which have not been reported from our country. They have also not been incorporated in any of the lists of Indian fungi^{1-3,5} published so far.

The records are summarized in Table I.

The range of the conidial size of the above organisms generally agrees with the range reported for the parent types. Slight variations were, however, observed for *Pestalotiopsis versicolor* where the range of the conidial length was slightly less. The setæ of *Colletotrichum*

TABLE I
Leafspot diseases: hosts, causal organisms, and size of the conidia

Name of the host	Name of the pathogen	Size and shape of the conidia
1. <i>Kigelia binnata</i>	.. <i>Phyllosticta kigeliae</i> Died.	9.1-13.3×4.4-6.2 μ, hyaline, ellipsoidal, slightly globose
2. <i>Eriobotrya japonica</i>	.. <i>Phyllosticta eriobotryæ</i> Thüm.	4.9-7.0×2.6-3.0 μ, lightly grayish in colour and ellipsoidal in shape
3. <i>Heliconia rubra</i>	.. * <i>Phyllosticta dardanoi</i> Batista * <i>Fusarium sambucinum</i> Fuckel	2.3-5×1.1-1.5 μ, hyaline, very small and ellipsoidal Macroconidia → 18.7-23.1×5.4-7.5 μ, hyaline, fusiform, pointed at both the ends. Microconidia → 3.5×1.5-2 μ hyaline
4. <i>Sansevieria macrophylla</i>	.. * <i>Fusarium semitectum</i> Berk. and Rav.	Macroconidia → 11.7-18.2×2.6-4.1 μ, pale, sub-clavate, now and then abruptly inflated Microconidia → 3.6-5.4×1.5-2.6 μ, hyaline
5. <i>Eugenia jambolana</i>	.. * <i>Pestalotiopsis versicolor</i> (Speg.) Stey.	17.24-7×6.8-10.0 μ, coloured cells versicoloured, apical cell with 2-3 setæ
6. <i>Quisqualis indica</i>	.. * <i>Colletotrichum capsici</i> (Syd.) Butler and Bisby	19-24×3.5-5 μ, hyaline, setæ very long
7. <i>Dracæna terminalis</i>	.. * <i>Dictyarthrinium sacchari</i> (Stevenson) Damon	11-13×9-12 μ, dark brown, mostly four celled arranged in cross-like divisions, very rough wall
8. <i>Elettaria cordamomum</i>	.. * <i>Nigrospora oryzae</i> (Berk. and Br.) Petch	13-15.6×8.8-13 μ, black with a hyaline vesicle at the base which may be present or absent
9. <i>Bassia latifolia</i>	.. do.	15.9-18.2×13-15.6 μ, dark brown or black, vesicle may be present or absent, a highly sporulating form

capsici were generally longer. The conidia of *Nigrospora oryzae* (isolated from the leaves of *Bassia latifolia*) were remarkable for their larger size and variable shape. The three species of *Phyllosticta* have not been reported from India on any host.

The cultures of the fungi marked (*) have been deposited in Commonwealth Mycological Institute, Kew.

The authors are grateful to Dr. J. C. F. Hopkins, Director, Commonwealth Mycological Institute, Kew, for identification of some of the species.

Botany Department,
Allahabad University,
November 30, 1960.

R. N. TANDON.
K. S. BILGRAMI.

1. Butler, E. J. and Bisby, G. R., *The Fungi of India—Scientific Monograph No. 1*, Government of India Central Publication Branch, Calcutta, 1931.
2. Mundkur, B. B., *The Fungi of India—Supplement I, Scientific Monograph No. 12*, Government of India Publication, Delhi, 1938.
3. Ramakrishnan, K. and Subramanian, C. V., "The Fungi of India—Supplement II," *J. Madras Univ.*, 1952, 22 B, 163.
4. Steyaert, R. L., *Bull. Jard. Bot. Brux.*, 1949, 9, 285.
5. Subramanian, C. V. and Ramakrishnan, K., "List of Indian Fungi—1952-56," *J. Madras Univ.*, 1956, 26 B, 327.

SCREENING SUGARCANE VARIETIES FOR RESISTANCE TO ROOT KNOT NEMATODE, MELOIDOGYNE JAVONICA

NEMATODES, as pests of sugarcane, are now receiving attention in many sugarcane-growing countries. In India, yellowing and growth failure of certain varieties was noticed during 1957¹ in the nematode infested area at Nelli-kuppam (Madras State). Rangaswami *et al.*²

recorded two types of nematodes in the area, viz., *Meloidogyne javonica*, causing visible symptoms of root knot and *Tylenchorhynchus* sp. Rao³ inoculated sugarcane setts with root knot nematode and found galls developing at the root tips in 7-10 days.

In the Nelli-kuppam factory area, the sugarcane crop was observed to develop root knots during July-August, i.e., from about the fifth month after planting. Examination of the roots of many varieties revealed varying number of galls on the roots and they could be classified into three categories, viz., (1) mild infestation with few knots; (2) medium infestation with knots readily noticed but not numerous and (3) severe infestation with large number of knots. In certain severely infested varieties like H. 32-8560, symptoms of attack like stunted growth and yellowing of leaves were noticed.

In view of varietal differences in the infestation of nematode as judged from knot numbers, studies were undertaken to see whether varieties could be easily screened for resistance to the nematode infestation.

Nine varieties, three from each of the infestation levels were taken up for the study and ten one budded cuttings in each planted at random in a sand-bed infested with a fairly uniform population of the root knot nematode. Examination of the setts after a week for knot formation revealed distinct varietal responses (Fig. 1). While all the varieties did show terminal knot formation, the relative percent roots recording terminal knots varied with varieties. Knots of varying sizes (1.73 to 4.37 mm. diameter), most of them globular, were observed even in the same variety. The number of larvae per knot (average of ten knots) varied from 29.3 to 43.9 depending

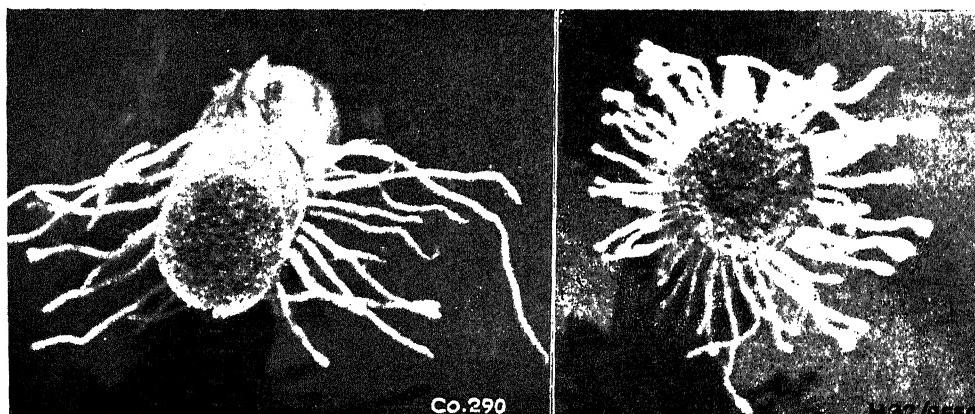


FIG. 1. H 32/8560 showing terminal root knots and Co. 290 comparatively free.

on the size of the knot. No parasitic fungus was found to infect the roots.

The data gathered are presented in Table I.

TABLE I

Percent setts affected and percent roots showing knots

Variety	Visual rating of infestation	Percent setts affected	Percent roots showing knots
Co. 853	Severe	100	32.4 ± 4.5
C.P. 29/116	,	100	29.0 ± 3.8
H. 32-8560	"	90	20.9 ± 3.5
Co. 419	Medium	70	10.4 ± 1.8
Co. 449	"	80	15.0 ± 2.1
Co. 527	"	80	4.8 ± 1.3
Co. 290	Mild	50	2.5 ± 0.5
Co. 711	"	80	3.7 ± 1.7
Co. 997	"	60	4.2 ± 1.3

The relationship between percent roots showing knots and degree of infestation of a variety is generally close. It thus appears possible to compare the degree of infestation among varieties from a knowledge of the percent roots developing knots.

One week rooted single eyepieces thus appear to be good indicators of varietal infestation to root knot nematode and that rapid screening of seedling varieties is possible by this method. No structural differences were noticed in the anatomy of roots as between varieties with varying infestation levels.

Thanks are due to Dr. N. R. Bhat, Director, for interest, encouragement and advice in the preparation of the note.

Sugarcane Breeding Inst., U. VIJAYALAKSHMI.
Coimbatore-7, J. T. RAO.
May 17, 1961.

1. David H., *Ind. Jour. Sug. Res. and Dev.*, 1957, 3, 234.
2. Rangaswami, G., VasanthaRajan, V. N. and Venkatesan, R., *Curr. Sci.*, 1960, 6, 236.
3. Rao, G. N., *Sci. and Cult.*, 1961, 27, 94.

GALL MIDGE ASSOCIATED WITH SUGARCANE INFLORESCENCE

DURING the last hybridisation season, while attempting to use one of the improved hybrid varieties, Co. 951, in breeding as a pistillate parent (it is a male sterile variety) it was noticed that the ovary and stylar branches in many of the spikelets were being injured by an insect. Closer examination revealed the presence of short, oval-shaped, orange-coloured segmented larvæ which fed on the ovarian

tissue and were later attached to the style (Fig. 1). Over 50% of the younger spikelets



FIG. 1. Note damaged ovary and larva attached to style.

in an arrow were noticed to be thus infested. In the older ones, adult-winged insects were noticed in fairly large numbers. The presence of the larvæ and the adult in one and the same arrow led to the belief that the insect is not a casual visitor but is actually phytophagous feeding and breeding on the spikelets.

Seeds collected from the arrows were noticed to be black in appearance and failed to germinate. This may be due presumably to the under-nourishment of the developing embryo caused by the feeding of the insect on the ovarian tissue.

The insect has been identified as a gall midge of the genus *Contarinia*. According to Barnes¹ no gall midges have been recorded on the sugar plants, sugarcane or sugar-beet. This is presumably the first record of gall midge associated with sugarcane and injurious to its normal seed development. The midge can be a potential nuisance to the sugarcane breeder inasmuch as it has rendered the variety Co. 951 sterile and useless as a genetic stock.

So far only Co. 951 has been noticed to be attacked by the midge and none of the many varieties in its close proximity. Also the variety was found to be infested in various parts of the field. The possible explanation for this varietal

preference may be that Co. 951 flowers very late and is in full bloom when other varieties have practically finished arrowing and have only late stray arrows on them. Probably, the flowering period in Co. 951 might have coincided with the period of maximum flight of the midge. Such an association has been noticed in many crops (Barnes, loc. cit.).

Grateful thanks are due to Miss Margaret K. Arnold of the Rothamsted Experiment Station, England, for identification of the midge. Thanks are offered to Dr. N. R. Bhat, Director, and Dr. J. T. Rao, Botanist, for their interest and encouragement.

Sugarcane Breeding Institute, A. S. ETHEIRAJAN.
Coimbatore-7,
May 2, 1961.

1. Barnes, H. F., *Gall Midges of Economic Importance*, 1949, 6.

OCCURRENCE OF ROOT-KNOT NEMATODES ON BETELVINE IN MAHARASHTRA

BETELVINE (*Piper betel* L.) is one of the important cash crops in Maharashtra. It is being grown

in the vascular bundles of roots. Samples of root-galls were sent to Dr. F. G. W. Jones, Nematologist, Rothamsted Experimental Station, Harpenden, Herts, England, who kindly identified them as belonging to the species *Meloidogyne incognita* var. *acrita* Chitwood (1949). A similar damage to betelvine suspected to be caused by nematodes is also reported from Madras in 1926.¹

The first visible symptom of the disease is blackening and dropping of the growing tip of betelvine during the month of October. When the disease develops the entire betelvine shows sickly appearance, leaves turn pale-yellow in colour, droop and fall to the ground. Ultimately the entire vine wilts. Root galls varying in size and shape are formed. These ultimately decay in the soil liberating millions of eggs, larvae and females every year. Thus the nematode population in the soil increases and ultimately the soil becomes unfit for growing betelvine. When a root-gall is cut open, egg masses are observed as whitish, glistening, round, pin-point-like bodies embedded in the root tissues. If a small portion of this material is examined under the microscope eggs, male and female can be observed (Fig. 1a). The female is pyriform (Fig. 1b) in shape while

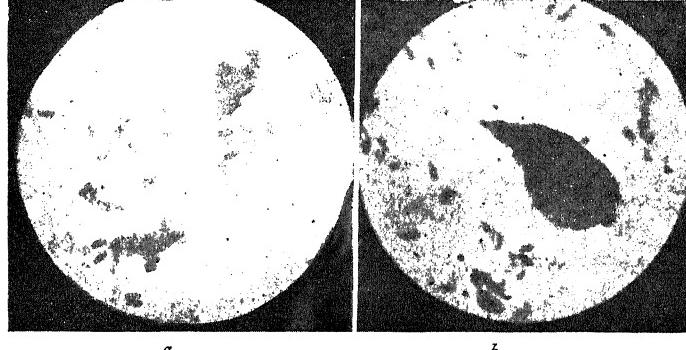


FIG. 1. (a) Eggs and larvae of nematodes, $\times 80$. (b) Female of nematodes, $\times 80$.

throughout the State in localized areas wherever soil and climatic conditions are favourable. In recent years, wilt caused by root-knot nematodes (*Meloidogyne incognita* var. *acrita* Chitwood, 1949) was observed at Vadner Bhairao (Dist. Nasik) causing considerable damage to betelvine. Examination of affected specimens from many places in the State revealed that the disease was caused by root-knot nematodes inciting galls on betelvine roots. Microscopic examination of the galls revealed the presence of eggs, larvae, males and females of nematodes

the males are filiform and in general outline differ from the larvae.

During the last three years experiments to control nematodes were conducted with non-phytotoxic soil fumigants, nematicides and insecticides. Diazinon (Basudin) a phosphorus containing compound has given promising results in controlling root-knot nematodes. Detailed account is being published elsewhere.

Grateful thanks are due to Dr. B. S. Kadarm, Joint Director of Agriculture, Poona, for his guidance and valuable suggestions, and to the

Indian Council of Agricultural Research, New Delhi, for financing the scheme.

Plant Pathology Section,
College of Agriculture,
Poona-5, May 26, 1961.

G. W. DHANDE.
M. SULAIMAN.

1. Krishna Ayyar, P. N., *Madras Agric. J.*, 1926, 13,
113.

A BACTERIAL LEAFSPOT DISEASE OF JASMINE

DURING 1958-61 the jasmine plants (*Jasminum sambac* Soland) in the Annamalainagar area of Chidambaram, Madras State, were found affected by a bacterial leafspot disease. The same disease has also been observed in some parts of Salem and Coimbatore districts during the same years. Both the bushy and climber types of varieties of jasmine were found affected. The disease symptoms first appear as minute water-soaked lesions on the upper surface. These lesions soon become yellowish-green and enlarge in size. Several spots coalesce to form linear or irregular spots, which give a characteristic mosaic-like appearance to the leaf (Fig. 1). On



FIG. 1. Leafspots on *Jasminum sambac* Soland caused by *Xanthomonas jasmini*, Rang. and Esw., sp. nov.

each leaf several spots may appear in a crowded form but in some varieties there may be only a few localized spots. No other plant parts appear to be affected by the bacterium. In the case of severely affected plants there is defoliation and stunted growth of the plants. Transverse sections of the leaves through the affected tissues clearly indicated the presence of the bacterial cells in the affected tissues. The bacterium was brought into culture by the tissue culture method and was purified by the single colony method. When inoculated on

healthy plants of different jasmine varieties by spraying the bacterial suspension on the leaves, infections were obtained, the symptoms becoming visible after seven days. The bacterium was reisolated from the lesions and was found to be identical with the original inoculum.

Elliott¹ has listed *Jasminum primulinum* Hemsl. as one of the several hosts for *Pseudomonas savastanoi* (E.F.Sm.) Stevens and *Ps. syringae* van Hall. There appears to be no earlier report of any bacterial disease on any species of *Jasminum* in India. The bacterium under the present investigation differs considerably from those mentioned above in its morphological, physiological and biochemical as well as pathological characters and is therefore named *Xanthomonas jasmini*, sp. nov.

Xanthomonas jasmini RANGASWAMY AND
ESWARAN, SP. NOV.

Short rods, $2\cdot1\text{-}4\cdot2 \times 0\cdot7\text{-}1\cdot4 \mu$, single, rarely in chains of two or three, monotrichous with single polar flagellum, aerobic, non-acid fast, Gram-negative, non-capsulated and non-spore-forming. Forms flat, circular, entire opaque and non-glistening yellow colonies on nutrient agar and yellow growth with sedimentation in nutrient broth. No soluble pigment is produced in the liquid or agar media. Gelatin is liquefied rather slowly, but starch is hydrolysed rapidly and litmus milk is coagulated with acid production, but litmus in the milk not reduced. H_2S is not produced by the bacterium, but ammonia produced; gives positive M.R. and lypolytic activity tests and negative indol and V.P. tests. Utilizes glucose, sucrose, maltose, lactose, raffinose, rhamnose, galactose, xylose and levulose as carbon sources, with acid production but no gas formation; also utilizes potassium nitrate, ammonium dihydrogen phosphate, urea, glutamic acid, aspartic acid and tryptophane as nitrogen sources.

Causes leafspot on *Jasminum sambac* Soland and on artificial inoculation failed to infect *Zinnia elegans* Jacq., *Tagetes erecta* Linn., *Cosmos sulphurens* Cav., *Impatiens balsamina* Linn., *Hibiscus rosasinensis* Linn., *Antigonon leptopus* Hook. and Arn., *Justicia* sp., *Crossandra undulæfolia* Salisb., *Nerium odoratum* Soland, *Euphorbia pulcherrima* Willd., and *Canna indica* Linn.

Department of Agriculture, G. RANGASWAMI.
Annamalai University, K. S. S. ESWARAN.
Annamalainagar, Madras State,
May 11, 1961.

1. Elliott, C., *Manual of Bacterial Plant Pathogens*, Waltham, Mass., U.S.A., 1951.

CASSIA TORA: LOCAL LESION HOST OF TOBACCO MOSAIC VIRUS

DURING study of comparative host ranges of four different virus diseases of plants reported from India, *Cassia tora*, a commonplace weed, was observed to produce dark-brown local necrotic lesions in 8 to 10 days after inoculation with the Johnson's tobacco virus 1 (tobacco mosaic virus).¹ Experiments were carried out to compare the local lesions formed on leaves of *Cassia tora* inoculated with and without an abrasive, diluted and undiluted juice of tobacco leaves, and on test plants preconditioned in dark and those grown in full daylight.

At least 10 times more lesions are formed on *Cassia tora* plants preconditioned in dark for 4 days before inoculation than on those grown continuously in light.² Lesions begin to appear after 4 days and are well developed within 10 days. They are about 2 mm. in diameter to begin with but slightly enlarge, broaden, and grow deeper in colour with age. They, however, do not coalesce but necrosis may develop sometimes along the veins (Fig. 1). Systemic infection in *Cassia tora* does not occur. Preliminary studies have shown that *Cassia tora* is useful local lesion and differential host plant of the type strain of tobacco mosaic virus (TMV). Further studies are in progress.

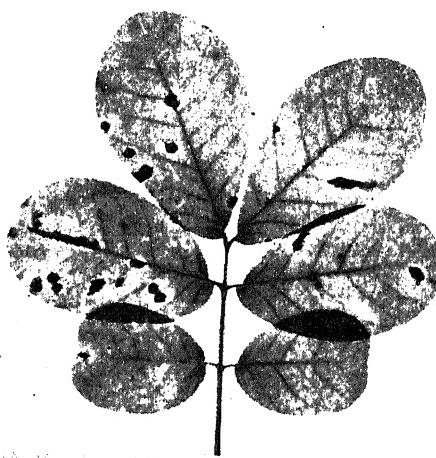


FIG. 1. Leaf of *Cassia tora* showing local necrotic lesions of TMV. (Photo 15 days after inoculation.)

Earlier records show that cassia virus, strains of tobacco etch virus, potato virus Y, and Black-eye cowpea mosaic virus³, tobacco ringspot virus, tomato ringspot virus, and potato virus X⁴, and Cymbidium mosaic virus⁵ induce formation of local necrotic lesions or spots on leaves of *Cassia tora* plants.

This study is the first report of infection caused by the type strain of TMV in *Cassia tora*. Brooks⁶ and Anderson³ failed to infect *Cassia tora* with tobacco mosaic virus in repeated attempts.

Indian Agric. Res. Institute,
Plant Virus Res. Laboratory,
Poona-5, March 23, 1961.

S. P. CAPOOR.

1. Johnson, J., "The classification of plant viruses. Wisconsin," *Agr. Expt. Sta. Res. Bull.*, 1927, **76**.
2. Bawden, F. C. and Roberts, F. M., *Ann. Appl. Biol.*, 1948, **35**, 418.
3. Anderson, C. W., *Plant Dis. Reporter*, 1954, **38**, 736.
4. —, *Ibid.*, 1958, **42**, 932.
5. Corbett, M. K., *Phytopathology*, 1960, **50**, 346.
6. Brooks, A. N., *Florida Agr. Expt. Sta. Ann. Report*, 1937, **1936**, 94.

A SIMPLE METHOD OF DETERMINATION OF GLYCOGEN CONTENT OF MARINE ANIMALS

A RAPID method for the determination of glycogen in animals was described by Van Der Kleij (1951)¹ as well as Kemp and Heijningen (1954)² which involved the hydrolysis of glycogen obtained after precipitating the proteins with cold trichloroacetic acid, and determining the sugar by the spectrophotometric method described by Mendel and Hoagland (1950).³ This method has been used for the determination of the glycogen content of marine animals by Lane, Posner and Greenfield (1953)⁴ and Raymont and Krishnaswamy (1960).⁵ This is however sensitive for sugar levels ranging from 50 to 150 µg. per ml. In the course of a study of the glycogen content of the marine wood-boring pholad *Martesia fragilis* it was found that the glycogen content was very high. Hence the procedure had to be modified so that the resultant colour produced after the addition of sulphuric acid could be read in a photoelectric colorimeter using a blue filter instead of in a spectrophotometer.

The sample was ground with chemically pure sand and cold 5% trichloroacetic acid containing 0.2% silver sulphate, as in the case of marine animals it was found that 0.1% silver sulphate was not sufficient. The rest of the procedure was essentially the same as described by previous workers.^{1-3,5,6} The extract was transferred into a centrifuge tube, made up to 5 ml. and boiled for 15 minutes, cooled in running tap-water and centrifuged. The glucose determination was carried out after addition of 1 ml. of the supernatant solution to 3 ml. of concentrated H_2SO_4 (Analar grade). The material

was then boiled for 6·5 minutes in a water-bath and cooled immediately in running tap-water. Standards were prepared containing glucose ranging from 250 to 1,000 µg. per ml. The colorimetric readings showed a linear relationship up to 750 µg. and followed Lambert Beer's law. Beyond this concentration (*i.e.*, 750 µg.) the graph takes a steep upward rise which was not predictable. The experiments were repeated using a spectrophotometer at 520 m μ wavelength for both the animals and standards and the sugar content read off from the graphs. The glycogen content expressed in terms of sugar for animals of different sizes vary. However, the results obtained by using the two different methods gave the same values and showed that the colorimeter could be conveniently used for the determination of higher concentrations of glucose (*i.e.*, beyond 150 µg. and up to 750 µg.).

We wish to thank Dr. E. R. B. Shanmugam Sundaram, Head of the Department of Biochemistry, Madras University, for critically going through the paper and Prof. T. S. Sadasivan, Professor of Botany, University of Madras, for permitting us to use the spectrophotometer.

Zoology Research Lab., V. V. SRINIVASAN.
University of Madras, S. KRISHNASWAMY.
Madras, April 28, 1961.

1. Van Der Kleij, B. J., *Biochem. biophys. Acta*, 1951, 7, 481.
2. Kemp, A. and Van Kits Heijnen, A. J. M., *Biochem. J.*, 1954, 56, 646.
3. Mendel, B. and Hoagland, P. L., *Lancet II*, 1950, 1, 16.
4. Lane C. E., Posner, E. G. S., and Greenfield, L. J., *Bull. Mar. Sci. Gulf Carrib.*, 1953, 2 (2), 385.
5. Raymond, J. E. G. and Krishnaswamy, S., *J. Mar. biol. Ass. U.K.*, 1960, 39, 239.
6. Mendel, B., Kemp, A. and Myers, D. K., *Biochem. J.*, 1954, 56, 639.

NEW HOST PLANT OF COLOCASIA BLIGHT (*PHYTOPHTHORA COLOCASIAE RACIB.*)

BLIGHT caused by *Phytophtora colocasiae* Racib. is known to be a serious disease of Colocasia (*Colocasia antiquorum* Schott.), in India, during the monsoons (Butler, 1918). There are no other naturally occurring host plants of this disease (Butler and Bisby, 1931).

In 1959, during the months of August and September, at the Central Potato Research Station, Patna, young plantations of elephant-foot yam (*Amorphophallus campanulatus* Blume), an important vegetable crop in many parts of India, were observed to be severely attacked by a foliage blight. Microscopic examination of the disease tissues revealed the presence of sporangiophores and sporangia of *Phytophtora* which, on the basis of morphology,

was identified as *Phytophtora colocasiae* Racib. During 1960 Kharif season, elephant-foot yam was planted with Colocasia to study the occurrence of Colocasia blight on elephant-foot yam. In July, blight first appeared in an epiphytic form on Colocasia. Within a fortnight, disease spread to elephant-foot yam, growing near the infected plants of Colocasia. Cross-inoculation tests were undertaken during August and September. The authors were able to transmit the disease repeatedly from Colocasia to elephant-foot yam and vice versa, by using fresh sporangial suspension on the detached leaves and young potted plants in the moist chambers. All the inoculated leaves developed typical symptoms of blight within 36–72 hours and produced sporangiophores and sporangia on the diseased spots.

Since the disease on elephant-foot yam has not been reported, an annotated account of the symptoms, and the fungus associated with it, is presented.

In early stages the disease is manifested by the appearance of light-brown, water-soaked, necrotic, round to regularly-shaped lesions on the leaf. The margins are often zonated in different shades of brown, green and yellow. In later stages they enlarge and usually coalesce, involving large part of the leaf area. The severely affected leaves shrivel and dry up. Frequently the petioles are also infected. The intensity of attack depends, as in potato blight [*Phytophtora infestans* (Mont.) deBary], on the atmospheric conditions. The intensity of blight was greater in shady places than in open fields.

The detailed examination of diseased lesions showed that infection is mainly by zoospores. The germ tubes penetrate both through the stomata and epidermis and give rise to profusely branched mycelium, which rapidly spread in the intercellular spaces of the leaf. From the internal hyphae, sporangiophores emerge singly through the stomata and epidermis. The sporangia are hyaline, elliptical, very irregular in size (35–50 \times 20–25 μ) and are borne singly at the tip of very short, narrow and unbranched sporangiophores. No other spore forms were found on Colocasia and elephant-foot yam.

The authors are grateful to Dr. Pushkarnath, Director, Central Potato Research Institute, Simla, for providing facilities of work.

Central Potato Res. Station, K. D. PAHARIA.
Patna (Bihar), P. N. MATHUR.
May 25, 1961.

1. Butler, E. J., *Fungi and Diseases in Plants*, Thacker, Spink & Co., 1918.
2. —, and Bisby, G. R., *Fungi of India*, I.C.A.R. Science Monograph (Revised by R. S. Vasudeva), 1960.

REVIEWS

Theory of Probability. By William Burnside. (Dover Publications, New York). Pp. xxx + 106. Price \$1.00.

Theory of Probability is the synthesis and expansion of a number of individual papers published by Burnside over a period of years. Printed posthumously, it is the expression of his views so far as they were framed into a system. Though this work does not resolve all the difficulties of the problem, it is a remarkable work by a distinguished scholar, throwing light on many difficult concepts.

This essay, unavailable for many years, presents numerous problems in classical probability which offer many original views on the subject. They include discussions of the game theory, progressive games with counters, cards, selections from groups, spinning of a coin, division of lines, games of substituting for drawn objects, and similar topics. Geometrical probability is treated in such areas as: suppositions as to probability of position of a point on a line, points on the surface of a sphere, and Poincare's problem on the probable number of intersections of two closed curves on a sphere.

Besides the book contains a thirty-page biographical memoir of Burnside. V.

Meson Physics. By Robert E. Marshak. (Dover Publications, Inc., New York), 1959. Pp. viii + 378. Price \$1.95.

The book had its inception in a series of lectures given by the author at the universities of Rochester and Columbia, and appeared first in the year 1952. The subject-matter of the volume has by no means acquired a final character and that is perhaps one of the reasons for the enormous activity in the field. There is a need for a book comprising the important results that are available only in research papers, and the present one satisfied this admirably.

The first four chapters of the volume elucidate the behaviour of charged and neutral π mesons at non-relativistic nucleon energies, with special attention being given to the accelerator experiments which were increasingly more incisive in their determination of the properties of the π mesons. Chapters 5 and 6 draw attention to the striking contrasts between π and μ mesons. Chapter 7 deals with the characteristic problems associated with the nuclear interaction of π

mesons. Chapter 8 discusses π meson production phenomena at relativistic nucleon energies. Chapter 9 discusses the theoretical difficulties created by the discovery of new classes of particles, like heavy mesons and hyperons.

A. J.

Cambridge University Press Publications: (The Bentley House, 200, Euston Road, London, N.W. 1) :—

1. *The Mathematical Theory of Electricity and Magnetism.* By Sir James Jeans. Pp. 652. Price 25 sh. (Paper bound).
2. *The Mathematical Theory of Relativity.* By A. S. Eddington. Pp. 270. Price 16 sh. (Paper bound).
3. *The Mathematical Theory of Non-uniform Gases.* By S. Chapman and T. G. Cowling. Pp. 431. Price 17 sh. 6 d. (Paper bound).
4. *Elementary Matrices.* By R. A. Frazer, W. J. Duncan and A. R. Collar. Pp. 416. Price 17 sh. 6 d. (Paper bound).

These four publications of the Cambridge University Press are well known treatises on the subjects concerned and have been so popular with students and teachers through these years that frequent reprints were necessitated since their original publication three, four or five decades ago. The C.U.P. are doing a good service to the English-speaking student community of the Universities all over the world, in making these classics now available in cheap paper cover editions.

Sir James Jeans' treatise is the standard general work on electricity and magnetism and covers the topics in electromagnetic theory in simple mathematical language.

In the book on Relativity, Sir Arthur Eddington, in his characteristic clear style, formulates mathematically the new conception of the world of physics arising out of the theory of relativity and follows out the consequences to the fullest extent.

Chapman and Enskog deal mainly with the mathematical theory of transport phenomena—viscosity, thermal conduction, and diffusion—in non-uniform gases, based on Maxwell-Boltzmann equations. The later chapters deal with the quantum theory of the transport phenomena, and electromagnetic phenomena in ionized gases.

The well-known text-book on *matrices* by the three authors starts with the first principles and develops the subject with special reference to its applications to differential equations and classical mechanics. Though the title states that the book is elementary, discussions of advanced questions and complicated problems are also included thus making the book more useful. Worked numerical examples taken from aerodynamics have a considerable practical importance.

A. S. G.

Impulse Voltage Testing. By W. G. Hawley.
(Published by Chapman and Hall Ltd.), 1959.
Pp. viii + 183. Price 32s.

This monograph is an outcome of the author's efforts to pool the information about impulse voltage technique and testing, scattered in a large number of research papers and specifications, into a convenient form for teaching this art in Engineering Schools and Colleges and, particularly, to the industrial laboratory staff engaged on this class of work.

The first three chapters deal pertinently with the significance of impulse voltage testing, impulse withstand voltage values for power system apparatus and definitions relating to the testing. In Chapter 3, the basic theory of impulse circuits is presented. Of course, an elementary knowledge of Heaviside Operational Calculus is assumed from the reader. The next four chapters describe, at length, single- and multi-stage impulse generators giving relevant design considerations and some details of its auxiliary equipment. It is surprising to note that no mention is made about the role of stray capacitances in the successful firing of the multi-stage impulse generator while explaining its mechanism in Chapter 6. An elementary account of measurement and recording of impulse voltages is given in Chapters 9 to 12. For finer points of measurement the reader is referred to the original papers. The testing of overhead power line insulators, power transformers, overhead transmission lines, power cables and power capacitors is described in Chapters 15 to 19. There is also a chapter on correction for atmospheric conditions. Relevant information about testing procedures is liberally extracted wherever applicable from I.E.C. specifications. Last chapter indicates miscellaneous applications of the impulse testing. There are eight appendices giving useful information about items like the earthing by means of buried electrodes, Silko resistance ribbons, etc.

On the whole, this book provides a comprehensive and up-to-date coverage of the art of

impulse voltage testing of all power system apparatus that are exposed to severe transient over-voltages of atmospheric origin. No account of testing of lightning arresters is given on the ground that the impulse test is more in the nature of a heavy current test. But in view of the increasing importance of the knowledge of the volt-time characteristic of the series gap of the lightning arresters for the purpose of insulation co-ordination it is hoped that the standard wave test of the lightning arresters will be included along with the technique of measurement of front-chopped impulse voltages in future edition. It will be useful if the recent revisions made in the relevant international specifications are incorporated in the future edition. An additional appendix on impulse current testing of the lightning arresters will enhance the worth of the monograph.

There are a few misprints in the present publication but they are fairly obvious (pages 10, 18, 78, 79 and 92).

As the first book in English devoted exclusively to this subject it is a worthy addition to the 'popular series of Monographs on Electrical Engineering'.

D. J. BADKAS.

Advances in Analytical Chemistry and Instrumentation, Vol. I. By C. N. Reilley.
(Interscience Publishers, New York), 1960.
Pp. 445. Price \$ 12.00.

The seven chapters of this volume, written by authorities in respective fields, are of great value to the research chemists.

The first chapter on tetraphenylboron as an analytical reagent by Flaschka and Barnard not only includes a detailed account of the different methods employed in the determination of potassium with TPB, but also other diverse uses of TPB in inorganic and organic analyses. The chapter is well written and references to the literature have been cited extensively. The chapter on gas chromatography detectors by Seligman and Gager is an excellent review wherein the authors make an evaluation of the various methods of vapour detection. The advantages in using high sensitivity ionization devices, hydrogen flame detectors and radiochemical detectors have been discussed. The recent methods for the determination of fluorine in inorganic compounds have been discussed by Horton in Chapter 3. The methods of analysis of organic fluorine compounds have been completely omitted. Horton points out the need for further research on several aspects of the methods of determination of fluorine. The

fourth chapter on organic microanalysis by Schöniger deals with handling of the latest type of microbalance, inclusive of setting of table, mode of weighing, etc., critical evaluation of latest methods of combustion for the estimation of different elements separately as well as simultaneously. Reinmuth has written the chapter on theory of electrode-processes with emphasis on electroanalysis and has discussed the nature of electrode reactions, experimental techniques and the effects of experimental variables on electrode processes. The use of thioacetamide in inorganic analysis is the subject-matter of a chapter by Swift and Anson. The use of thioacetamide in inorganic analysis will undoubtedly gain more importance in future and may even completely replace the conventional methods employing hydrogen sulphide. The qualitative and quantitative applications of near-infra-red spectrophotometry ($1-3 \mu$ region) in chemical analyses have been discussed in a clear and concise manner by Goddu in the last chapter of this volume, and this may be considered particularly valuable in view of the current availability of several instruments of excellent make.

D. K. BANERJEE.
C. N. R. RAO.

The Chemistry of the Terpenes. By A. R. Pinder (Chapman and Hall Ltd., 37, Essex Street, London, W.C. 2; India: Asia Publishing House, Bombay-1), 1960. Pp. vii + 223. Price 50 sh.

The object of writing this book by Professor Pinder is to acquaint the Honours undergraduate students with the essentials of terpene chemistry, which would also include recent developments in the field, while restricting its volume within a reasonable limit, and this has undoubtedly been achieved. The whole subject has been systematically presented with emphasis on degradation reactions, syntheses, and molecular rearrangements involved in its chemistry. Recent developments in the stereochemistry and biosynthesis of terpenes have not been ignored. There have been few notable omissions, e.g., prominent reference to Woodward's contribution to biosynthesis, syntheses of irone, reference to Bhattacharyya in connection with the synthesis of podocarpic acid, etc.

D. K. BANERJEE.

Comparative Biochemistry, Vol. I. Sources of Free Energy. Edited by M. Florkin and H. S. Mason. (Academic Press, New York and London), 1960. Pp. xxv + 590. Price \$ 18.00.

In recent years the importance of comparative biochemistry is being increasingly recognized and an attempt is made in the first volume of this comprehensive treatise to consider the structural and functional similarities and diversities among living organisms from the molecular level.

The volume begins with an introduction to comparative biochemistry written by the editors Florkin and Mason wherein they elaborate two important concepts, namely, that life is consistent with the fundamental properties of matter and energy and is a consequence of them and secondly that there is a common ground plan of composition and metabolism and superimposed on these are numerous secondary adaptational variations.

The second article by Byring, Boyce and Spikes discusses the basic principles of classical thermodynamics and the steady state systems which are of particular interest to living organisms. The theory of absolute reaction rates which can be used as a complementary approach to the study of living systems is also clearly explained.

In their review on the comparative mechanisms of fatty acid oxidation Stumpf and Barber consider the β -oxidation of fatty acids as the common denominator on which are superimposed the variants that have developed in different tissues and in different phyla in response to their specific needs.

Energy-yielding reactions and 'energy-rich' compounds which are potential energy reserves in living systems are reviewed by Huennekens and Whiteley who discuss the chemical and thermodynamic aspects of energy-rich compounds and point the way to further developments.

The present state of our knowledge of the chemical properties of onium compounds and their natural distribution is summarized by Cantoni who has made valuable contributions to the biochemistry and intermediary metabolism of this type of compounds. The chemistry of onium compounds, energetics of the onium bond, transfer reactions from an onium pole and the enzyme mechanisms in the formation of the onium bond are all described in great detail.

The phenomena of phototropism and phototaxis, the role of auxins in phototropism in plants and the nature of photoreceptors are discussed by Thimann and Curry, while Wald contributes a stimulating article on the distribution and evolution of visual systems.

Fromageot and Senez give a survey of the biochemical processes which produce free

energy from inorganic substances. The oxidation of nitrogen and sulfur compounds and of molecular hydrogen are described in this chapter and their relative importance as the energy-yielding reaction in different phyla critically examined.

The last three chapters pertain to the comparative biochemistry of glycolysis, electron transport and oxidative phosphorylation and the utilization of thermal energy by living organisms.

This volume fills a real need in giving a critical and most satisfactory survey of a field which is rapidly growing in importance and can be unreservedly recommended as an indispensable reference volume for advanced students and research workers in comparative biochemistry.

P. S. SARMA.

Royal Institute of Chemistry, Monographs for Teachers

No. 4. *Principles of Metallic Corrosion*. By J. P. Chilton. Pp. 64. Price 6 sh.

No. 5. *Principles of Chemical Equilibrium*. By P. G. Ashmore. Pp. 49. Price 4 sh. 6 d.

These are the titles of the fourth and fifth items in the series of *Monographs for Teachers*, published by the Royal Institute of Chemistry and sponsored by the Institute's Fund for the Development of Education in Chemistry.

These publications are intended for the guidance of those who teach chemistry at G.C.E. Advanced level and above, but the monographs will doubtless be of value to a wider readership, including more advanced students of chemistry.

Copies may be obtained from the Royal Institute of Chemistry, 30, Russell Square, London, W.C. 1.

D. G. C.

Cellulose Research Symposium, (II)—1958.
(The Council of Scientific and Industrial Research, Rafi Marg, New Delhi-1), 1960. Pp. xii + 156. Price Rs. 12.

This publication of twenty-seven papers on Cellulose Research read and discussed in four sessions at the Second Symposium held in the Forest Research Institute, Dehra Dun in 1958, by the Council of Scientific and Industrial Research, New Delhi, gives not only to the research worker a scope for further studies but also to the Cellulose allied industries a probe into the possibilities of manufacture of their products by new techniques which will go a long way to solve the problem of our country's shortage of cellulose raw materials. Industries like the Jute, Paper and Rayon shoulding the programmes, etc.

encourage such furtherance of knowledge on Cellulose Research to their mutual advantage by contributing to the Institutions conducting such research and giving them specific problems to solve.

The structure and physical properties of cellulose, the chemistry and technology have been well brought out in the few papers published but their successful application in the manufacture of Newsprint and Viscose Rayon is yet to be a 'fait accomplie'. Of the short fibred hardwoods the possibility of manufacture of writing and printing papers from wattle wood is explained in one paper. But the use of this raw material can only be restricted as the pulp from wattle wood should be mixed up with at least 50% of longer fibred pulp like bamboo pulp before they can be run trouble free on a high speed machine as per trials conducted at the Mysore Paper Mills, Bhadravati. Since our country is facing acute shortage of Cellulose raw materials for all the allied industries, research and pilot plant trials on the choice of fresh raw materials from easily and quickly growing Hard Wood and their successful application to the Industry for the manufacture of Paper and Viscose Rayon is now of utmost importance.

V. K. S.

Biological and Chemical Control of Plant and Animal Pests. A Symposium presented by Section O on Agriculture at the Indianapolis Meeting of the American Association for the Advancement of Science, December 28-30, 1957. Pp. 273. Edited by L. P. Reitz. (Publication No. 61 of the American Association for the Advancement of Science, Washington, D.C.), 1960. Pp. 285. Price \$ 5.75.

The book is a symposium purporting to give a survey of what has been accomplished in the past 25 years in the field of disease and pest control through Chemical and Biological means. It also touches on the aspect of what may be done in future in this direction.

The symposium is presented in three parts with papers written by specialists based on extensive review of literature in each field. References are listed at the end of each chapter for further consultation.

Part I consisting of five papers is devoted largely to impress on the reader the stake every citizen has in pest and disease control and it includes topics like National Policy—Eradicating programmes—Control of insects and diseases in forests—Need of public co-operation in achieving the programmes, etc.

The four papers in Part II deal with the recent concepts and developments about chemicals (Insecticides, fungicides and weedicides)—their mode of action as killing agents on weeds, disease organisms and insects, as well as internal animal parasites.

Part III refers to biological control of pests and comprises nine chapters. It treats exhaustively the interdependent nature between predators—antagonists—parasites and the environment. Mention is also made on the aspect of breeding for resistance. The author hints that biological control, though less dramatic than chemical control, is the ideal way to control pests as it precipitates no residual problems.

Within the framework of the above objects there is no doubt that the book is valuable with contributions from experts on related fields. The manner in which the problem is approached and the style in which it is presented evokes praise at every point that the writer desires to make out has been driven home conclusively.

However, the whole of the efforts relates to work done in the U.S.A. and the reader would look for any work done in other countries in the several fields as conditions in these countries would naturally differ from the American conditions as also pests and diseases.

M. PUTTARUDRIAH.

Principles of Animal Virology. (2nd Edition).

By F. M. Burnet. (Academic Press, New York; India : Asia Publishing House, Bombay-1), 1960. Pp. ix + 490. Price \$ 12.00.

Sir Macfarlane Burnet's book is well known and it remains as one of the best text-books on Animal Virology. Rapid progress in virus research during the past few years, has justified a revision of the book. Nearly half the book has been rewritten omitting a chapter of the earlier edition. Apart from the physical and chemical properties of viruses, multiplication and liberation of virus from the host cells and its interference and pathogenesis, evolution and ecology of viruses are discussed in sufficient detail. The book has been written with inferences drawn from selective references, but this does not in anyway minimise the value of the book. In fact this approach to the subject should prove more useful both to the student and the research worker alike.

V. N. K.

Books Received

General Physical Science. By G. G. Mallinson, J. B. Mallinson and R. F. Welch. McGraw-Hill Book Co., New York), 1961. Pp. xii + 628.

A Text-Book of Inorganic Chemistry. By A. K. De. (Science Book Agency, P. 133, Lake Terrace, Calcutta-29). Pp. viii + 503. Price Rs. 11.

Text-Book of Organic Chemistry—Parts I and II.

By P. C. Bhattacharya. (Mrs. Gowri Bhattacharyya, P.O. Agarpara, North Station Road, 24 Parganas), 1961. Part I: Pp. vii + 315. Part II: Pp. vii + 250. Price Rs. 7. each part.

A Dictionary of Named Effects and Laws—in Chemistry, Physics and Mathematics (2nd Revised Edition). By D. W. G. Ballentyne and L. E. Q. Walker. (Chapman and Hall, 37, Essex Street, W.C. 2 ; India : Asia Publishing House, Bombay-1), 1961. Pp. v + 234. Price 30 sh.

Review of Food Technology (Vol. 2). (The Association of Food Technologists, Mysore-2), 1961. Pp. xvii + 168. Price Rs. 7.50.

Oceanography. Edited by M. Sears. (American Association for Advancement of Science, Washington, D.C., 1961. Pp. xi + 654. Price \$ 14.75.

From: (John Wiley and Sons Ltd., 440, Park Avenue South, New York-16 ; India : Asia Publishing House, Bombay-1).

Quantum Mechanics. By E. Merzbacher, 1961. Pp. xii + 544. Price \$ 12.00.

Elementary Fluid Mechanics (4th Edition). By J. K. Vennard, 1961. Pp. xiv + 570. Price \$ 7.95.

Error Correcting Codes. By W. W. Peterson, 1961. Pp. x + 285. Price \$ 7.75.

From: (Academic Press Inc., 111 Fifth Avenue, New York-3, N.Y. ; India : Asia Publishing House, Bombay-1).

Measure, Lebesgue Integrals and Hilbert Space. By A. N. Kolmogorov and S. V. Fomin, 1961. Pp. xii + 147. Price \$ 4.00.

Advances in Morphogenesis (Vol. 1). Edited by M. Abercrombie and J. Brachet, 1961. Pp. xiii + 445. Price 89 sh. 6 d.

Name Reactions in Organic Chemistry (2nd Edition). By A. R. Surrey, 1961. Pp. x + 278. Price \$ 8.00.

From: (Cambridge University Press, 200, Euston Road, London, N.W. 1).

Partial Differential Equations of Mathematical Physics. By H. Bateman, 1959. Pp. xxii + 522. Price 27 sh. 6 d.

The Methods of Plane Projective Geometry Based on the Use of General Homogeneous Coordinates. By E. A. Maxwell, 1960. Pp. xix + 230. Price 13 sh. 6 d.

A First Course in Mathematical Statistics. By C. E. Weatherburn, 1961. Pp. xv + 277. Price 18 sh. 6 d.

SCIENCE NOTES AND NEWS

Award of Research Degree

The Osmania University has awarded the Ph.D. Degree in Zoology to (Miss) Amir Sultana for her thesis entitled "Studies on the Nematode Parasites of the Birds of Andhra Pradesh (India)".

Annamalai University has awarded the Ph.D. Degree in Chemistry to Sri. V. Ramakrishnan for his thesis entitled "The Cryoscopic and Conductance Behaviour of some Organic Compounds in Ethanolamine".

Seventh Congress on Theoretical and Applied Mechanics

The Seventh Congress on Theoretical and Applied Mechanics will be held from December 23 to 26, 1961, at the Indian Institute of Technology, Bombay, Powai, Bombay-76.

Research papers may be contributed on any of the following topics : (1) Elasticity, Plasticity and Rheology ; (2) Fluid Mechanics (Aerodynamics and Hydrodynamics) ; (3) Mechanics of Solids (Ballistics, Vibration, Friction and Lubrication) ; (4) Statistical Mechanics, Thermodynamics and Heat Transfer ; (5) Mathematics of Physics and Statistics ; (6) Experimental Techniques ; (7) Computation Methods.

They should reach Dr. M. K. Jain, Officiating Secretary, with three copies of Abstracts by October 15, 1961.

Application Forms for Registrations and any other information may be obtained from the Officiating Secretary.

Control of Paddy Blast and Wheat Rusts

Messrs. R. S. Mathur, J. S. Jain and M. P. Misra, Section of Plant Pathology, Uttar Pradesh Government, Kanpur, write :

(I) In field trials on the control of paddy blast by organic mercury dusts, the comparative efficacy of the following three treatments was tested against blast caused by *Piricularia oryzae* Cav. at the Usar Reclamation Farm, Chakeri (Kanpur), during the 1960-61 seasons.

(1) Ceresan and lime machine mixed in the ratio of 1 : 6 (0.3% Hg) ; (2) the same hand-mixed, and (3) Agrosan GN formulation (0.2% Hg).

After the first prophylactic dusting at the boot stage, the crop was dusted twice as a preventive measure against blast at intervals of 10 days. In the three treatments crop's yields showed

'increases of 41, 35 and 8% respectively in 0.05 acre plots, over the check plots which showed moderate to severe infection of blast.

(II) In a field trial on chemical control of wheat rusts, the efficacy of two spray fungicides, Dithane Z-78 (Zinc ethylene bis dithiocarbamate) and 0-3818 B (Nickel chloride hexa hydrate mixed with Dithane Z-78) was tested at Kanpur on an artificially rust-infected crop of Agra Local wheat in 1960-61. One prophylactic and two protective sprays completely controlled moderate and heavy infections of brown and black rusts.

A Simple Method of Hatching of Cysts of *Heterodera major* O. Schm.

Shri Gopal Swarup, Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi, writes : During the course of investigations of 'Molya' disease of wheat and barley, caused by *Heterodera major* O. Schm., some difficulty was experienced in getting daily a crop of freshly hatched larvae for inoculation purposes. Though it is well known that cysts of this nematode do not need any root diffusate or chemical stimulant for hatching, yet merely keeping the cysts in tap-water did not yield a good hatch. Probably lack of oxygen is the chief reason for low hatching potential. The following simple method proved successful for obtaining a good crop of hatched larvae for experimental work throughout the season. A circular piece of muslin cloth was stitched all round to a wire ring which could just conveniently go inside a petri dish, and rest on three glass rods placed in it. The petri dish was nearly filled with tap-water, and the wet muslin was always in contact with water. Batches of cysts were kept on top of the muslin along with a check wherein cysts were just put in water. The dishes were kept one over the other at room temperature (20-25° C.). The difference in the hatching was observed within 24 hours ; the cysts kept on muslin cloth giving 50% more hatching than those placed in water. The hatched larvae could be taken out daily and freshwater added.

Marine Fossiliferous Lower Eocenes from Dharmshala, Punjab

Dr. B. S. Tewari, Geology Department, Lucknow University, writes : Recently, a traverse was taken by the author and Shri P. S. Misra

of Dharmasala, of the Manjhi Khad about three miles east of Dharmasala with a view to investigate in detail the occurrence of the marine fossiliferous beds of Eocene age in the region as first reported upon by Dr. M. R. Sahni (*Rec. Geol. Surv. India: General Report for 1946*). Marine Eocene beds which have been referred to the Subathus occur at Subathu—Dharampur in Simla region on the eastern side, and Jangalgali and Pirpanjal Range in Jammu and Kashmir State on the Western side of the present locality.

About a mile north of the bridge over the Manjhi Khad, on the mule track leading to Kanihara from Dharmasala, there is an outcrop of dark grey, compact foraminiferal limestone in association with purple, red and grey shales on the right bank of the Manjhi Khad, containing *Nummulites atacicus*, N. cf. *mamilla*, *Assilina dandotica*, *A. spinosa*, *A. subspinosa* and badly preserved casts of Molluscs. The beds are thrusted against the massive Dharmakot Limestone and dip at a high angle towards north. The structure, however, is very complicated. The Grid Reference of the locality is D 600003 or the one inch map sheet No. 52 D/8.

The study confirms that the foraminiferal limestone referred to the Nummulities by Dr. Sahni is of Lower Eocene age and is referable to the lower part of the Subathus.

High Intensity Magnet

The completion of a solenoid magnet at M.I.T. which generates a continuous magnetic field of 126 kilogauss signals the advent of an exploratory tool expected to have widespread scientific implications. It can, for example, help develop electron microscopes of unprecedented resolution, broader solid-state research experiments, and influence magnetohydrodynamic power generation.

Magnetic fields of a million gauss have been achieved with pulsed apparatus, but such fields have durations of only a microsecond or millisecond. Field produced in laboratory iron magnets have been limited by practical gap size and by the value at which iron saturates. Elimination of the iron requires approximately 1,000 times as much current to generate a field of equal intensity.

The design of the new magnet is due to H. Kolm of M.I.T. Lincoln Laboratory. The magnet consists of a tapered, 135-foot long ribbon of copper scored with 300 square slots and wound with insulation into a cylinder. Cooling water is forced between the aligned slots at 320 gallons per minute. In the centre

of the coil is a tube, one inch in diameter by two inches long. An intense field is produced in the tube as 10,000 amperes of current pass through the coil. The principal limiting factor is the amount of well-regulated d-c power available. Cooling also imposes limitations. The Kolm magnet, built and tested at the available operating power of 1.88 megawatts, generates 126 kilogauss and is working at the new National Magnet Laboratory, M.I.T.

Among solid-state experiments that can take a giant step forward with high fields are the cyclotron resonance measurements of semiconductors. To get cyclotron resonance at sub-millimeter or infra-red wavelengths, a field of at least 200 kilogauss is needed. In the far-infra-red frequencies, work with pulsed fields is difficult and inaccurate, so continuous fields are needed.—(*Electronics*, July 28, 1961.)

Taxonomy of the Earthworm in India

Earthworms, apparently sent simultaneously to the British Museum (Natural History) and to the American Museum of Natural History for identification, have directed attention once more to the deplorable state of the taxonomy in a genus that may be dominant in a considerable portion of the Indian Peninsula. Each of the species left in that genus by a revision by G. E. Gates in 1939, based on an over-all somatic rather than genital anatomy, has remained indefinable hitherto. Material now studied by Gates, at the University of Maine, has enabled recognition not only of two further characters for generic definition but also has permitted, for the first time, fairly satisfactory characterization of a species based on data such as variation in sexual individuals secured in lots of some size from several localities (*Ann. Mag. Nat. Hist.*, 3, 35, November 1960). Previously unpublished information included in his account was obtained from 90 specimens collected for him at three localities in the Jubbulpore region during the Second World War.—(*Nature*, 1961, 191, 227.)

Carbon Dioxide Estimations in Stored Grain as Indication of Condition

The temperature of stored grain is widely used as a reliable guide to its condition during storage, and most modern grain elevators are provided with various types of grain temperature meters. A rise in temperature indicates metabolic activity by mould or insects.

Metabolic activity which causes the rise in temperature is also accompanied by production of carbon dioxide, and estimation of carbon

dioxide concentration in the intergranular atmosphere of stored grain will provide a method of detecting unwanted metabolic activity in the storage. In a note published in *Tropical Science* (1961, Vol. III, No. 1), Calderon and Shaaya have presented results of their experiments to assess the efficiency of the method.

The instrument used was a gas analyzer originally designed to measure fumigant concentrations by comparing the thermal conductivity of the experimental sample with that of a sample of air not containing carbon dioxide. The apparatus was calibrated by inserting amounts of carbon dioxide into a reservoir so as to yield graded concentrations of 0-15%. Samples of intergranular air were sucked into the gas analyzer through polyethylene tubes, probing to different depths in grain bins holding wheat or sorghum.

The results demonstrate the usefulness of the thermal conductivity analyzer for supervising grain in storage. The method promises to give sensitive indication of deterioration of bulk grain, whether due to insects or dampness.

Infra-Red Molecular Emission Spectroscopy by a Michelson Interferometer

The combination of a two-beam Michelson interferometer and Fourier transformation offers new prospects for the emission spectroscopy of sources of low brightness. Its effective application in the infra-red region 2-12 μ , where many molecular vibration bands are formed, has been described in a note by Gebbie *et al.* published in *Nature* (1951, 191, 264).

The low temperature radiation from a gas (e.g., ammonia) contained in a heated cell with rocksalt windows, after chopping, passes through a specially designed Michelson interferometer to a detector. The interferogram of the radiation of the emitting gas is sampled at equal intervals of path-difference by a signal derived from the record of the mercury fringes. The values of intensity at these points are digitized and punched on paper tape suitable for input to a digital computer, where a programme for Fourier transformation gives the spectrum. The output of the computer is plotted automatically on a recorder. Comparison with an emission spectrum made with a conventional prism spectrometer shows that much superior resolution and signal-to-noise ratio is possible with the interferometer in comparable times of observation.

The Michelson-Fourier combination can be used for work on night-sky emission and also for observations on planetary atmospheres. Another possibility being investigated is the application to Raman spectroscopy with excitation lines of longer wavelength than those normally used.

Biochemical Composition of Coconut Water

Coconut water, the liquid endosperm of *Cocos nucifera* L., is used as a supplement in media for the growth of plant tissue cultures. Tissues from embryos, roots, stems, endosperm and pollen of plants, including angiosperms and gymnosperms, may be grown on media containing this liquid. W. Tulecke *et al.* in a contribution from Boyce Thompson Institute (1961, Vol. 21, p. 115) describe the normal constituents of coconut water as it is used in the culture of plant tissues.

Malic is the predominant organic acid. Alanine, γ -amino-butyric acid, and glutamic acid constitute about 75% of the free amino-acids of the fluid from mature fresh coconuts. Glutamine, arginine, asparagine, alanine and aspartic acid make up about 70% for young green coconuts.

Shikimic and quinic acids were detected in all samples, the greatest amounts being found in young green coconuts. This is perhaps the first report of these substances in coconut water. The probable role of these alicyclic acids in aromatic biosynthesis indicates their importance in the developing coconut; it is possible that they also play a role in the nutrition of plant tissue cultures.

The sugar content increases from 0.9 μ /100 ml. in young fruits to 2.2 g./100 ml. in mature green coconuts. While the RNA-phosphorus content of fruits of different ages is fairly constant (about 30 μ g./mg.), the DNA-phosphorus content increases from 0.06 μ g./mg. in young green to 3.46 μ g./mg. in mature coconuts.

It may be that other growth factors, lipid constituents, minor elements, etc., will be found. But the information already available should assist in the more rational use of coconut water as a supplement in nutrient media.

ERRATUM

In the June 1961 issue of *Current Science*, Column 1, line 10 from bottom on page 223 should read $XAC = -5.6^\circ$ and not $XAC 5.6^\circ$.

622-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, *Current Science Association*, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

INTERNATIONAL CONFERENCES

1. THIRD INTERNATIONAL CONFERENCE ON NEUROSECRETION

THE concept that the nerve cells function as glandular units to bring about homeostasis and differentiation through chemical means of an endocrine nature, is of recent origin due to workers like the Scharrers, Bargmann and Hanström. The first symposium on this aspect of biological study, known as Neurosecretion, was organised in Naples in 1953, bringing together the active workers in the field for the first time. The histological and functional aspects of neurosecretory cells were discussed and the outcome of the symposium was the general acceptance of neurosecretion as a fundamental phenomenon in animals. The second symposium held in Lund in Sweden in 1957 brought out the functional significance of the secretory neurons in greater detail and this helped to formulate the existence of a neuro-endocrine system in animals.

The third International Conference on neurosecretion was held in Bristol in England from 8th to 13th September 1961. About sixty delegates, drawn from twelve nations including India, participated in this symposium. This Conference was divided into five sections and the papers presented and discussed covered structural and physiological aspects of the secretory neurons in both vertebrates and invertebrates.

One of the major subjects presented to the meeting related to the ultra-structure of the neurosecretory systems, revealed by studies using the electron microscope. Bern, Nishioka and Hagadoorn (Berkeley) presented an account of their studies on the neurosecretory cells of the leech, the cockroach, *Aplysia* and the frog, and demonstrated the relation between the golgi apparatus and the cellular secretion and the presence of neurofibrils in these cells. Knowles (Birmingham) described the ultra-structure of the neurohaemal organs known as pericardial organs of *Squilia*; while B. Scharrer (New York) and E. Scharrer and Brown (New York) presented their observations on the fine structure of the neurosecretory cells of the insect *Leucophaea* and the earthworm *Lumbricus* respectively.

Notable contributions relating to the comparative histology and histochemistry of vertebrate neurosecretory systems were from Arvy (Jouy-en-Josses) on the enzymatic histochemistry of the cells and from Howe (London)

on the relation between arginine and neurosecretory colloids in the pituitary of mammals. The observable relationship between the neurosecretory activity, photoperiodism and the cyclical activity of the testes of the sparrow presented by Farner (Pullman) and Oksche (Kiel); the effect of dehydration on the development of hypothalamic centres controlling water metabolism by Rodeck (Datteln); the physiological changes in the neurosecretory system of the fish by Stahl and Leray (Marseille); and the demonstration of the distribution of the hormones oxytocin and vasopressin in the mammalian hypothalamic nuclei by Lederis (Bristol) formed some of the significant presentations revealing the physiology of the neurosecretory cells in vertebrates.

Three sessions were devoted to the papers on invertebrate neurosecretion. The histology and histophysiology of the system in Annelida were presented in the works of Herlant-Meewis (Brussels) who showed the relationship between regeneration and neurosecretory phenomena in *Eisenia*; of Clark, Clark and Ruston (Bristol) on similar phenomena in polychaets; of Clark (Bristol) who brought out evidences to show the influence of neurosecretion on growth and reproduction in polychaets; and of Hagadoorn (Berkeley) who described the neurosecretory phenomena in the leech *Theromyzon*.

Neurosecretion in insects were studied essentially from the histophysiological and embryological points of view. Lea (Vero Beach) and Thomsen (Copenhagen) described the cyclical activity of secretion as revealed by dark ground microscopy, in the median neurosecretory cells of the brain of the blowfly; Khan and Fraser (Glasgow) described the developmental history and influences of the neurosecretory cells of the brain in the embryos of the cockroach *Periplaneta*; and Nayar (Trivandrum) described the probable inhibitory effect of the juvenile hormone-extracts on the release of neurosecretory material into the blood of the cockroach comparable to conditions of hydration in insects. Arvy (Jouy-en-Josses) and Gabe (Paris) described the histochemistry of the neurosecretory cells and the corpora cardiaca of several insect groups. Highnam (Sheffield) presented a resume of his work on the desert locust demonstrating the influence of neurosecretory activity on the ovarian development and the initial experiments using radioisotopes to follow up the pathways of this influence.

Two papers dealt with neurosecretion in crustaceans. Bliss (New York) described the complex endocrinological control of locomotor activity in the crab *Gecarcinus*; and Menon (Trivandrum) gave an account of the neurosecretory cells of the brachiopod *Streptoccephalus* recognising the existence of two specific structures as storage centres, one like a sinus gland within the eyestalk with the neurosecretory cells within the brain, and the other the frontal organs hitherto attributed with a varied function.

Prabhu (Trivandrum) described the neurosecretory system of the millipede *Jonespeltis* giving an account of the cells, their distribution and seasonal variations together with an account of a double storage centre in the connective body and the cerebral gland. Naisse (Brussels) gave an account of the neurosecretory cells and their structure and distribution in the opilionids.

In addition to these contributions, brief reports on research topics were also presented, in two afternoon sessions, covering aspects of neurosecretory histology and physiology in both vertebrates and invertebrates.

The Conference terminated with a closing address by E. Scharrer (New York). He stressed the significance of the neurosecretory cells in the organisation and physiology of the nervous system of animals and pointed out that the basic pattern of the neuro-endocrine system in animals is that of the glandular neurons and connected storage organs. In reply to a statement by de Robertis (Buenos Aires) made earlier in the Conference that nerve cells are all capable of producing substances and so all neurons are neurosecretory cells, he affirmed that though neurons can elaborate the neurohumours facilitating neuronal transmission, the neurosecretory cells do form a distinctive category of neurons both in their anatomy and physiology. They have to be dealt with separately as essential endocrine units.

The proceedings of the symposium will be published as Memoir No. 12 of the Society for Endocrinology.

As the host institution, the University of Bristol was courteous and friendly. Drs. Clark and Heller as the Organising Secretaries endeared themselves to all who participated in the symposium. There was a high degree of informality in the Conference. Most valuable of all was the chance to meet and talk with workers from the different parts of the globe and the exchange of ideas with the people was indeed rewarding. Especially enjoyable was the

trip to Avebury, where in a charming setting of old Britain of the times of Queen Elizabeth I in the Avebury Manor, the delegates were accorded a lordly reception by Sir Francis and Lady Knowles.

K. K. NAYAR.

2. FIRST INTERNATIONAL CONFERENCE ON PROTOZOOLOGY

Under the joint auspices of the Society of Protozoologists and the Czechoslovak Academy of Sciences, the First International Conference on Protozoology was held in the Hotel International, Prague, Czechoslovakia, from August 22nd to 31st, 1961. It was attended by over 200 protozoologists from several countries, including U.S.A., U.S.S.R., U.K., West and East Germany, France, Poland, Rumania, Hungary, Czechoslovakia, Japan and Egypt. A particularly large contingent of senior protozoologists came from U.S.S.R. including Professors Moshkovski, Cheissin and Poljanski. Prof. Garnham came from U.K. But the largest number was from U.S.A. and included Von Brand, Huttner, Trager, Tartar, Corliss and many others. India was represented by Prof. B. R. Seshachar and a number of younger workers.

The Conference was opened on the afternoon of August 22nd by Prof. I. Malek, Vice-President of the Czechoslovak Academy of Sciences. The languages of the Conference were Czech, Russian, English, French and German. Simultaneous translation facilities were available.

The morning session of the first working day was devoted to papers on the Taxonomy of Protozoa. It was clear that with the increasing knowledge of the Protozoa made available by the employment of newer techniques, some of the older views in regard to taxonomic relationships of Protozoan groups would merit revision. This was particularly well brought out by a number of workers like Corliss, Moshkovski and Honigberg. The afternoon session was devoted to papers on the Genetics of Protozoa. Siegel's paper on gene function and sexuality in *Paramecium bursaria* revealed that sexuality in this species was governed by genes at two loci and that immaturity, adolescence and maturity were expressions of these genes. The second day was devoted to papers on biochemistry of Protozoa and began with a talk by Von Brand on Achievements and goals in Protozoan biochemistry. Huttner's discussion on the role of Carbohydrates in the nutrition of Ciliates and flagellates was followed by a number of papers on the metabolic requirements of Protozoa,

notably by Johnson, Seaman, Schmoller, Trager and Provasoli. The cytology of Protozoa was dealt with in the morning session on the 25th August with papers by Dutta, Hawes, Seshachar and Tuffran. Raikov dealt with the problem of nuclear dualism in ciliates. The afternoon of that day was devoted to biophysics and a number of papers by Zeuthen and his colleagues from Copenhagen on Synchronization methods by temperature and other shocks were read, followed by papers on X-ray irradiation by Wichterman and Daniels. Dryl of Warsaw gave illustrations of movement of Paramecia in electromagnetic fields.

The Conference broke up into two sections on the morning of the 26th August. One occupied itself with discussion of papers on the Ecology of Protozoa while the other was devoted to Taxoplasmosis. Dr. E. Lund showed a beautiful film of *Taxoplasma* living cultures, illustrating the morphology, movement and reproduction in the organism. The Conference recessed on Saturday afternoon and Sunday. A sight-seeing trip of Prague was organized for Saturday after-

noon and a whole day excursion to Kárlovy-Vary and Marianske-Lazne was arranged on Sunday.

The Conference reassembled on Monday the 28th August for a day's discussion on Electron microscopy of Protozoa. Following Ludvik's paper, those of Pyne, Pappas, Yagiu and others showed the Conference the great advances in our knowledge of the ultra-structure of Protozoa. The last two working days of the Conference, i.e., 29th and 30th August, were devoted to papers dealing with the structure, life-history and host-parasite relationships of parasitic Protozoa. With the formal final session on the 31st the Conference came to a close.

It was the unanimous opinion of all those present that the Conference was helpful in bringing together workers in different aspects of Protozoan structure, life-history and relationships. Prof. O. Jirovec and his colleagues of the Protozoology Laboratory, Czechoslovak Academy of Sciences, spared no pains to make the delegates comfortable and the first Conference on Protozoology a great success.

B. R. S.

VOSTOK II—RUSSIA'S SECOND MANNED SPACE-SHIP

ON August 6, 1961, at 9 am. Moscow Time, the Soviet Union launched a new space-ship "Vostok II" on a round-the-earth orbit with a man aboard. The pilot was Major Gherman Titov.

The tasks of the flight were: To study the effects on the human body of prolonged orbital flight and descent to the surface of the earth; to study man's work capacity during a sustained state of weightlessness.

The space-ship was put into an orbit close to the calculated one, with the following parameters: Minimum distance from the surface of the earth (at perigee) was 178 kilometres; maximum distance (at apogee) was 257 kilometres; the inclination of the orbit to the equator was 64 degrees 56 minutes.

The initial period of revolution of the space-ship was 88·6 minutes. Minus the weight of the last stage of the carrier-rocket the space-ship weighed 4,731 kilograms.

Two-way radio communications were maintained with cosmonaut Titov. The cosmonaut transmitted on frequencies of 15·765, 20·006, and 143·625 megahertz. A transmitter "signal" operating on frequency of 19·995 megahertz was also on board the space-ship. The systems on board sustaining the cosmonaut's vital activity

functioned normally. The cosmonaut felt well throughout the flight and the controlled flight proceeded successfully.

Upon the successful completion of its programme of scientific research, the space-ship, in accordance with the approved flight programme, came to land at a pre-assigned spot in the Soviet Union, near the place where the space-ship "Vostok I" piloted by Major Yuri Gagarin, landed on April 12, 1961.

"Vostok II" made over 17 circuits around the earth in 25 hours 18 minutes, covering a distance of over 700,000 kilometres.

In the landing of the space-ship at a pre-assigned spot, the effect of the rotation of the earth will have to be taken into account. The landing of the space-ship on Soviet soil could have been effected after its first round, or, if that is missed, the cosmonaut should wait for 24 hours, when the earth would have turned once under him,—before he could land at the pre-assigned spot in Soviet territory. Thus Vostok I with Major Gagarin landed after one orbital round, whereas the space dogs, Strelka and Belka, which Russia launched on August 19, 1960, spent 24 hours in the space-ship, making 17 complete orbits, before the capsule containing them was brought down.

MULTIVARIABLE CONTROL SYSTEMS IN THE LIGHT OF SYMMETRICAL COMPONENTS

C. LAKSHMI-BAI AND R. L. KASHYAP

Department of Power Engineering, Indian Institute of Science, Bangalore-12

THE major obstacle in the analysis and synthesis of multivariable control systems is the presence of strong interaction between the controlled variables. In the existing literature¹⁻³ compensating matrices have been used to obtain non-interacting system, i.e., a system in which one-to-one relationship exists between the outputs and the respective commands. But the general multivariable system, without being compensated by the use of additional elements, has not been discussed from the point of view of stability limits.

The approach developed in this communication, which is fundamentally different from the existing methods, is based on the analogy between multivariable control systems and polyphase electric circuits. Thus the interaction appearing in multivariable systems can be advantageously studied in the light of symmetrical component theory which has been so widely and successfully used in the domain of polyphase circuits involving strong mutual coupling between phases. Hence for purposes of analysis and synthesis, an interacting system can be replaced by an equivalent set of non-interacting or feebly interacting systems. For these systems, stability analysis can be carried out conveniently on the basis of root locus or Nyquist criterion.

A multivariable feed-back control system is defined as a system which forms n output variables (y_1, y_2, \dots, y_n) from m input variables (x_1, x_2, \dots, x_m), so as to satisfy n equations of the form

$$F_i(y_1, \dots, y_n, x_1, \dots, x_m) = 0 \quad i = 1 \text{ to } n. \quad (1)$$

In terms of Laplace transforms, the equation of a single variable control system with forward transfer function G and unity feed back is given by

$$Y = RX, \quad R = \frac{G}{1+G} \quad (2)$$

or

$$X = R^{-1}Y = TY. \quad (3)$$

X, Y, R, T are respectively Laplace transform of command input, output, system transfer function and the inverse system transfer function.

The analogue of equation (2) in circuit analysis is the equation of single phase circuit

$$E = ZI \quad (4)$$

where

E is impressed voltage,
 Z is impedance of the circuit,
 I is response current.

In the case of general multivariable control system, the governing equation of the system is given by

$$\begin{aligned} X &= [J^{-1}G^{-1}(1 + JGH)] Y \\ &= TY \end{aligned} \quad (5)$$

where

J is the coupling matrix,
 G is the diagonal matrix, and
 H is the feed back matrix (diagonal).

Its analogue in circuit analysis is the equation of polyphase circuit

$$E = ZI \quad (6)$$

where

X, Y, E, I are all column matrices,
 T, Z are square matrices,
 T = inverse system transfer matrix,
 Z = system impedance matrix.

It can be easily seen that Z and T have similar properties and the problems in the two fields can be classified according to the nature of Z or T matrix.

TABLE I

Type	Diagonal terms	Non-diagonal terms	Nature of system
1	$Z_{11}=Z_{22}=Z_{33}$	$Z_{mn}=0$	Symmetrical ; non-interacting
2	$Z_{11}\neq Z_{22}\neq Z_{33}$	$Z_{mn}=0$	Unsymmetrical ; non-interacting
3	$Z_{11}=Z_{22}=Z_{33}$	$Z_{mn}\neq 0$	Quasi-symmetrical ; interacting
3A	$Z_{11}=Z_{22}=Z_{33}$	$Z_{12}=Z_{23}=Z_{31}$ $Z_{21}=Z_{32}=Z_{13}$	Symmetrical ; interacting
4	$Z_{11}\neq Z_{22}\neq Z_{33}$	$Z_{mn}\neq 0$	Unsymmetrical ; interacting
4A	$Z_{11}\neq Z_{22}\neq Z_{33}$	$Z_{12}=Z_{23}=Z_{31}$ $Z_{21}=Z_{32}=Z_{13}$	Only interaction is symmetrical

Problems of type 1 and 2 have presented no difficulty in both control systems and circuit analysis (or power system analysis). The majority of problems occurring in power system analysis is of type 3, 3 A. The method of symmetric components⁴ can be used elegantly for problems of type 3 A and 3. There is no elegant method for tackling problems of type 4, 4 A in power system analysis.

The object of this paper is to extend the theory of symmetrical components to the domain of control systems and hence solve problems of type 3 A and 3 in control systems. Next, a general method is evolved involving symmetrical components to tackle problems of type 4 A (where interaction is symmetrical) and problems of type 4 (general unsymmetrical case) to a certain extent. The method of solution for problems involving complete symmetry and interaction (Type 3 A) is to apply Fortescue's transformation to equation (5) and to get an equivalent non-interacting system characterised by the matrix T' called as sequence transfer matrix. As T' has only diagonal terms, it can be analysed for stability limits, etc., by root Locus or Nyquist charts. This method can be applied to problems of type 3 as well, except that sequence transfer matrix T' has non-diagonal terms also. They can be neglected if they are feeble (which is usually the case) and analysis carried out as before.

For problems of type 4 A (where only interaction is symmetrical) the procedure would be to split up the matrix T into two matrices T_s and T_m . T_s has only diagonal terms and T_m has only non-diagonal (and symmetrical) terms. As T_s is a diagonal matrix, it can be treated by usual methods. As T_m is symmetrical, the theory of symmetrical components can be applied to it so that the resultant sequence transfer matrix T' has only diagonal terms and hence can be solved by usual methods. This method can be extended to problems of type 4 (general unsymmetrical case), only if the mutual terms of T_m ' are feeble.

For illustration, the method is applied to the problem of the turbo-jet engine (which is of type 4—completely unsymmetrical case) for which experimental verification is available.⁵

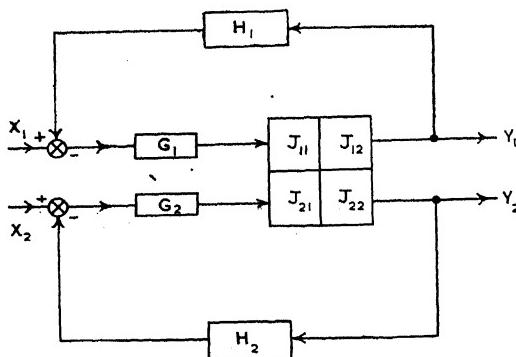


FIG. 1. Two-dimensional control system for the turbo-jet engine.

The variables to be controlled are the speed of rotation and turbine inlet temperature. The two plant inputs are fuel flow and exhaust nozzle area. The interaction is there, as a disturbance in fuel flow or exhaust nozzle area causes both the speed as well as the temperature to change. The block diagram is shown in Fig. 1. The figure is self-explanatory. Matrix J is the engine matrix which causes the interaction. G_1, G_2 are forward transfer functions, H_1, H_2 are feed-back transfer functions. Using matrix notation in s -plane,

$$\begin{aligned} Y &= JGE \\ &= JG(X - HY) \\ (1 + JGH)Y &= JGX \end{aligned} \quad (7)$$

or

$$\begin{aligned} X &= [G^{-1}J^{-1}(1 + JGH)]Y \\ &= TY \end{aligned} \quad (8) \quad (9)$$

$$\begin{aligned} T &= G^{-1}J^{-1}(1 + JGH) \\ &= G^{-1}J^{-1} + H \end{aligned}$$

$$= \begin{array}{|c|c|} \hline 1 & 0 \\ \hline G_1 & \Delta \\ \hline 0 & 1 \\ \hline \end{array} \quad \begin{array}{|c|c|} \hline J_{22} & -J_{21} \\ \hline \Delta & \Delta \\ \hline -J_{12} & J_{11} \\ \hline \Delta & \Delta \\ \hline \end{array} \\ + \begin{array}{|c|c|} \hline H_1 & 0 \\ \hline \Delta & \Delta \\ \hline 0 & H_2 \\ \hline \end{array}, \quad (10)$$

wherein,

$$\Delta = J_{11}J_{22} - J_{12}J_{21}.$$

Simplifying

$$T = \begin{array}{|c|c|} \hline J_{22} + H_1 & -J_{21} \\ \hline G_1\Delta & G_1\Delta \\ \hline -J_{12} & J_{11} \\ \hline G_2\Delta & G_2\Delta + H_2 \\ \hline \end{array} \quad (11)$$

$$= T_s + T_m. \quad (12)$$

$$T_s = \begin{array}{|c|c|} \hline J_{22} + H_1 & 0 \\ \hline G_1\Delta & G_1\Delta \\ \hline 0 & J_{11} \\ \hline G_2\Delta & G_2\Delta + H_2 \\ \hline \end{array}$$

$$= \begin{array}{|c|c|} \hline T_{11} & 0 \\ \hline \Delta & \Delta \\ \hline 0 & T_{22} \\ \hline \end{array} \quad (13)$$

$$T_M = \begin{vmatrix} 0 & -J_{21} \\ G_1 \Delta & 0 \end{vmatrix} = \begin{vmatrix} 0 & T_{12} \\ -T_{21} & 0 \end{vmatrix}. \quad (14)$$

$$X = (T_s + T_M) Y = X_s + X_M. \quad (15)$$

Splitting up equation (15) into 2 parts

$$X_s = T_s Y; \quad (16)$$

$$X_M = T_M Y. \quad (17)$$

Consider equation (17). It is quasi-symmetrical (Type 3). We can apply the theory of symmetrical components. For two-phase network, Fortescue's transformation matrix A is given by⁶

$$A = \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix}; A^{-1} = \frac{1}{2} \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix}. \quad (18)$$

Operating Fortescue's matrix on X_s and Y

$$\left. \begin{aligned} X_s &= AX_s' \\ Y &= AY' \end{aligned} \right\}. \quad (19)$$

Substituting (19) in (17)

$$AX_s' = T_M AY'$$

or

$$X_s' = [A^{-1}T_M A] Y' \quad (20)$$

$$= T_M' Y'. \quad (21)$$

Sequence transfer matrix

$$T_M' = A^{-1}T_M A$$

$$= \frac{1}{2} \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix} \cdot \begin{vmatrix} 0 & T_{12} \\ -T_{21} & 0 \end{vmatrix}$$

$$\times \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix}$$

$$= \frac{1}{2} \begin{vmatrix} T_{12} + T_{21} & T_{12} - T_{21} \\ T_{12} - T_{21} & T_{12} + T_{21} \end{vmatrix}. \quad (22)$$

The term $(T_{12} - T_{21})$ is the difference of two interaction effects. Hence its strength is small when compared to that of $(T_{12} + T_{21})$ and can be neglected.

$$T_M' = \frac{1}{2} \begin{vmatrix} T_{12} + T_{21} & 0 \\ 0 & T_{12} + T_{21} \end{vmatrix} \quad (23)$$

and

$$X_M' = T_M' Y'. \quad (24)$$

Therefore stability of this system can be determined from the zeroes of diagonal elements of T_M' ,

i.e.,

$$(T_{12} + T_{21}) = 0. \quad (25)$$

Now equation (16) is considered. It is a non-interacting system and its stability is given by the zeroes of the diagonal elements,

i.e.,

$$T_{11} = 0 \quad (26)$$

and

$$T_{22} = 0. \quad (27)$$

Equations (25), (26) and (27) are the characteristic equations of the system.

The transfer functions used are

$$J_{11} = \frac{0.32}{1 + 1.75s}; J_{12} = \frac{0.618}{1 + 1.75s} \quad (28)$$

$$J_{21} = \frac{0.248(1+3.17s)}{1+1.75s}; \quad (29)$$

$$J_{22} = \frac{-0.417(1+0.07s)}{1+1.75s} \quad (29)$$

$$G_1 = K_N \frac{(1+1.75s)}{1.75s} \frac{31.3}{(1+0.10s)^2} \quad (30)$$

$$G_2 = -K_T \frac{(1+1.75s)}{1.75s} \frac{2.4}{(1+0.3s)(1+0.15s)} \quad (31)$$

$$H_1 = \frac{1}{1+0.05s}; H_2 = \frac{1}{1+s} \quad (32)$$

$$\Delta = J_{11}J_{22} - J_{12}J_{21} = -\frac{(0.286 + 0.495s)}{(1+1.75s)^2}. \quad (33)$$

Simplifying equation (25); (see footnote)*

$$T_{11} = \frac{E_{22}}{G_1 \Delta} + H_1$$

$$= \frac{E_{22}}{G_1 \Delta} \left(1 + \frac{G_1 H_1 \Delta}{E_{22}} \right) = \frac{E_{22}}{G_1 \Delta} T_{11}'. \quad (34)$$

All the information given by $T_{11} = 0$ is also given by $T_{11}' = 0$ as G_1 , G_2 , Δ , etc., have no poles in the right half of s-place.

Therefore

$$T_{11}' = 1 + \frac{G_1 H_1 \Delta}{E_{22}} = 0.$$

On substituting equations (28) to (33), the above equation becomes

$$T_{11}' = 1 + \frac{K_N \times 6.1 \times 10^5 (s + 0.576)}{s(s+10)^2(s+14.3)(s+20)} = 0. \quad (35)$$

Similarly

$$\begin{aligned} T_{22}' &= \frac{E_{11}}{G_2 \Delta} + H_2 = \frac{E_{11}}{G_2 \Delta} \left(1 + \frac{G_2 H_2 \Delta}{E_{11}} \right) \\ &= \frac{E_{11}}{G_2 \Delta} \cdot T_{22}' \end{aligned}$$

where

$$T_{22}' = 1 + \frac{G_2 H_2 \Delta}{E_{11}}.$$

On simplification, it becomes

$$T_{22}' = 1 + \frac{47 K_T (s + 0.576)}{s(s+1)(s+3.33)(s+6.66)} = 0. \quad (36)$$

Similarly,

$$\begin{aligned} T_{12}' + T_{21}' &= -\frac{E_{21}}{G_1 \Delta} + \frac{E_{12}}{G_2 \Delta} \\ &= -\frac{E_{21}}{G_1 \Delta} \left(1 - \frac{G_1}{G_2} \cdot \frac{E_{12}}{E_{21}} \right) \\ &= -\frac{E_{21}}{G_1 \Delta} T_{12}' = 0 \\ T_{12}' &= 1 - \frac{G_1}{G_2} \cdot \frac{E_{12}}{E_{21}} \\ &= 1 + \frac{4.6 K_N (s + 3.33)(s + 6.66)}{K_T (s + 10)^2 (s + 0.315)} = 0. \end{aligned} \quad (37)$$

Hence the effective characteristic equations are given by (35), (36) and (37).

Each of them is analysed by plotting Evan's root Locus (or Nyquist Chart). The maximum allowable values of K_N , K_T and K_N/K_T and their variation are found from Locus charts of (35), (36) and (37) respectively. Using these, a

graph of maximum value of K_N allowed for each value of K_T can be plotted. This gives the region of stability. It is found that the stability graph found by analysis is confirmed by that found by experiment. However, the region of stability given by the analysis is conservative when compared with the experimental investigations of Pack and Phillips.

CONCLUSIONS

(i) Mechanism of interaction has been analysed by means of theory of symmetrical components.

(ii) The general unsymmetric system has been separated into two systems—one having only self or diagonal terms and the other having only mutual terms. The stability of the former can be discussed directly, while that of latter can be analysed only after applying symmetrical components.

(iii) Stability limits can be found out on the basis of root Locus or Nyquist criterion.

* $E_{ij} = J_{ij}$, for $i=1, 2$ and $j=1, 2$.

1. Boksenbom, A. S. and Hood, R., "General algebraic method applied to control analysis of complex enginetypes," *N.A.C.A.(U.S.A.)*, 1950, T.R. 980.
2. Golomb, M. and Usdin, E., "A theory of multi-dimensional servo-systems," *J. of the Franklin Inst.*, Jan. 1952, 253, 29.
3. Freeman, H., "Stability and physical realizability considerations in the synthesis of multivariable control systems," *Trans.A.I.E.E.*, March 1958, 77, Part II, 1.
4. Wagner, C. F. and Evans, R. D., *Symmetrical Components*, McGraw-Hill Book Co., New York, 1933.
5. Pack, G. J. and Phillips, W. E., "Analogue study of interacting and non-interacting multiple-loop control systems for turbo-jet engines," *N.A.C.A. (U.S.A.)*, March 1954, T.N. 3112.
6. Clark, E., *Circuit Analysis of A.C. Power Systems*, John Wiley and Sons, 1943, 1.

FREE RADICALS IN CRYSTALS

Highly reactive 'free radicals', containing an odd electron unaccompanied by its partner with opposed direction of spin, may be produced when high energy radiation falls on organic crystals. These radicals readily form spin-paired molecules when the solid is dissolved or melted, but if held in the rigid solid they will last up to several months and can be studied directly by means of electron spin resonance spectroscopy.

The main spectroscopic transition is the reversal of the electron spin direction in a strong magnetic field by means of a quantum of microwave radiation. When the radical which holds the electron also contains nuclei which are

intrinsic magnets (e.g., H, ^{13}C , ^{14}N) a splitting occurs and hyperfine pattern of several lines is produced. Detailed interpretation of the number, positions and intensities of such lines gives information about nuclei present in the radical.

The most interesting of the new radicals so far discovered has been the ionic species CO_2^- produced by the effect of gamma rays on sodium formate. Since the dominant isotopes ^{12}C and ^{16}O are nonmagnetic, proof of the species was obtained by observing the 1% of radicals containing the isotope ^{13}C .—(*Research*, 1961, 14, 336.)

SYNTHESIS OF *p*-BENZOHYDROQUINONE-1-C¹³

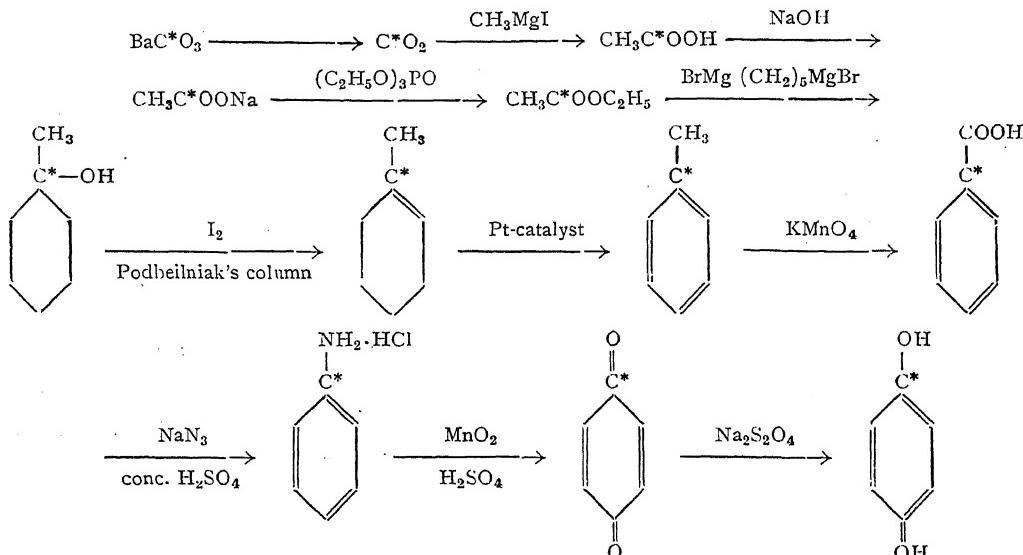
M. R. DAS

Atomic Energy Establishment Trombay

and

Tata Institute of Fundamental Research, Bombay

THE synthesis of hydroquinone labelled with C¹³ at the several positions has been undertaken for the purpose of studying the nature of the C¹³ hyperfine interactions in the corresponding semiquinone ions; the semiquinone ions are obtained by the atmospheric oxidation of an alkaline solution of the hydroquinone in ethanol. The hfs due to C¹³ in natural abundance has been reported in semiquinone ions¹ but has not been confirmed by studies on C¹³-enriched compounds. The synthesis of *p*-benzo-hydroquinone-1-C¹³ has been completed and the labelled compound has been obtained for the first time. It involved the following sequence of reactions:

1. Sodium Acetate-1-C¹³ (CH_3C^*OONa)

The conversion of BaCO₃ (enriched in C¹³ to about 48%) to sodium acetate was performed in a reaction vessel which was a modified version of the one used by Sakami, Evans and Gurin.² It consisted of a three-necked flask, to one neck of which was attached a small bent tube of 10 ml. capacity; in this tube the generated carbon dioxide was solidified using liquid air. Carbon dioxide generated from 10 gm. of BaC^{*}O₃ (48% enriched in C¹³) using 70 ml. of conc. H₂SO₄ was solidified in the cold limb. The use of conc. H₂SO₄ avoids the necessity of a separate drying tube. To ensure the expulsion

rator was heated until the barium sulphate dissolved in the excess acid.

The carbon dioxide generator was then disconnected from the reaction vessel without disturbing the vacuum and the side tube containing the solid CO₂ was allowed to warm up. The Grignard reagent, which was prepared from 2.5 gm. of Mg, 7 ml. of distilled CH₃I and 275 ml. of anhydrous ether, was added slowly while the bulb was cooled with a mixture of ice and salt. Since the amount of BaCO₃ was such that the pressure developed by carbon dioxide was less than the atmospheric pressure, the Grignard reagent was slowly sucked in when the stop-cock was opened. After the

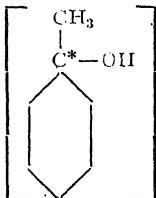
of any dissolved gas, the carbon dioxide generation was complete, the mixture was poured over 300 gm. of crushed ice and dilute sulphuric acid (7 ml. of conc. H₂SO₄ + 50 ml. of water) was added to dissolve the magnesium salts. The ether was evaporated off with a stream of air and 28 gm. of silver sulphate was added to the mixture. 25 ml. of conc. H₂SO₄ was then added gradually and the resulting solution was steam-distilled. Enough sodium hydroxide solution was added to the distillate to bring its pH to 8.8 and then it was slowly evaporated. When almost all the water had gone, the syrupy mass was transferred to a small flask and dried under

vacuum at about 100° C. The solid was finally dried for 3 hours at 110–120° C. under a pressure of 0·5 μ.³ Yield: 2·83 gm.; 68%.

2. Ethylacetate-2-C¹³ ($\text{CH}_3\text{C}^*\text{OOC}_2\text{H}_5$)

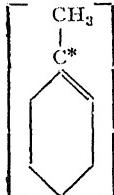
Sodium acetate was converted to ethylacetate using triethyl phosphate.³ The alkyl phosphate was preferred to the sulphate as it has a higher boiling point and is more stable at temperatures near 200° C. 9·8 gm. of the labelled anhydrous sodium acetate and 38 ml. of distilled ethyl phosphate was refluxed in a 250 ml. flask for an hour at 170–220° C.; an air-condenser followed by a small water condenser cooled with ice-cold water was used to avoid loss of the labelled acetate. The reaction mixture was kept overnight at room temperature and again refluxed for 2 more hours. The ethyl acetate was isolated as described by Ropp.³ Yield: 9·55 gm.; 90·7%.

3. Methyl Cyclohexanol-1-C¹³



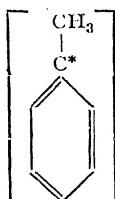
This was prepared according to the method described by Fields, Leaffer and Rothchild⁴ starting with 9·5 gm. of ethyl acetate. Yield: 6·61 gm.; 53·0%.

4. 1-Methyl Cyclohexene-1-C¹³



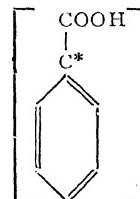
The dehydration of the tertiary alcohol was carried out using a Podbeilniak's column,^{4,5} in which glass coils were used in the place of copper coils. Starting with 6·6 gm. of the alcohol, yield: 2·2 gm.; 40·1%; $n_{D}^{25} = 1\cdot442$.

5. Toluene-1-C¹³



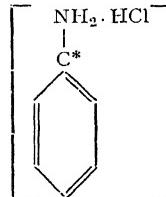
The dehydrogenation was carried out using 30% platinum-on-asbestos catalyst in place of the "Universal Oil Products" catalyst.⁴ Though the toluene obtained with Pt and Pd catalysts is not of very high purity,⁴ this was sufficient for further conversion to benzoic acid. With 2·1 gm. of methylcyclohexene, yield of toluene 1·35 gm. (67·7%); $n_{D}^{25} = 1\cdot481$.

6. Benzoic-1-C¹³ acid



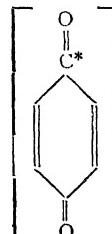
1·25 gm. of the toluene obtained was added without further purification to a solution of 5·1 gm. of potassium permanganate in 75 ml. water containing 0·3 gm. of sodium hydroxide and the side-chain oxidation was carried out in the usual manner.⁶ Yield: 0·91 gm. (54·4%); m.p. = 121·5° C.

7. Aniline-1-C¹³ hydrochloride



0·85 gm. of benzoic acid was converted to aniline hydrochloride by the Schmidt reaction according to the method described by Fields, Rothchild and Leaffer.⁷ An excess of sodium azide (2·5 moles per mole of acid) was used, as this excess was found to increase the yield to a considerable extent. Yield: 0·77 gm.; 85·4%; m.p. = 195° C.

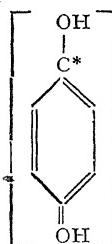
8. p-Benzoquinone-1-C¹³



0·77 gm. of aniline hydrochloride was dissolved in 28 ml. of water containing 2·8 ml.

conc. H_2SO_4 (96%); 5.5 gm. of MnO_2 was added and mixed by shaking. The mixture was immediately steam distilled and the distillation was continued until the distillate was colourless. The distillate was extracted several times with ether; the ether extract was dried over anhydrous sodium sulphate and evaporated to yield quinone. Yield: 0.33 gm.; 51.6%.

9. p-Benzohydroquinone-1-C¹³



The ether solution of the quinone was reduced to the hydroquinone using a solution of sodium hydrosulphite.⁸ The ether layer after separation was dried with anhydrous sodium sulphate. After drying it was allowed to evaporate and the residue was crystallised from alcohol. Yield of pure crystalline product: 0.171 gm. (50.9%); m.p. = 170°C.

The hyperfine structure found in the electron spin resonance spectrum of the semiquinone ion derived from the labelled hydroquinone has con-

firmed the presence of one C¹³ atom in the ring (with an enrichment of about 50%).⁹

ACKNOWLEDGEMENT

It is a pleasure to acknowledge that the problem was suggested by Dr. B. Venkataraman. The author is thankful to Professor S. S. Dharmatti for his keen interest in the work, Dr. B. Venkataraman for many helpful suggestions and Shri M. V. Krishnamurthy for help in the synthesis.

1. Van Roggen, A., *J. Chem. Phys.*, 1960, **33**, 1589; Reitz, D. C., Dravnieks, F. and Wertz, J. E., *Ibid.*, 1960, **33**, 1880; Strauss, H. L. and Fraenkel, G. K., *U.S. Air Force Report*, CU-8-61-AF-520-Chem, dt., April 15, 1961.
2. Sakami, W., Evans, W. E. and Gurin, S., *J. Amer. Chem. Soc.*, 1947, **69**, 1110; Spector, L. B., US AEC, MDDC 532; Cox, J. D., Turner, H. S. and Warne, R. J., *J. Chem. Soc.*, 1950, 3167; Murray, A. III and Williams, D. L., *Organic Syntheses with Isotopes*, Interscience Publishers, Inc., New York, 1958, p. 34.
3. Ropp, G. A., *J. Amer. Chem. Soc.*, 1950, **72**, 2299.
4. Fields, M., Leaffer, M. A., Rothchild, S. and Rohan, J., *Ibid.*, 1958, **74**, 5498.
5. Whitemore, F. C. and Lux, A. R., *Ibid.*, 1932, **54**, 3448; Mosher, W. A., *Ibid.*, 1940, **62**, 552.
6. Weissberger, A., *Micro and Semimicro Methods*, Interscience Publishers, Inc., New York, 1954, p. 271.
7. Fields, M., Rothchild, S. and Leaffer, M. A., *J. Amer. Chem. Soc.*, 1952, **74**, 2435.
8. Smith, L. I. and Austin, F. L., *Ibid.*, 1942, **64**, 528.
9. Das, M. R. and Venkataraman, B., *J. Chem. Phys.* (In Press).

EARTH'S CRUST UNDER INDIAN OCEAN

REPORTS on the scientific results of the two expeditions in the Soviet ship *Vityaz* in the Indian Ocean in 1959-61 were presented by Dr. Bezrukov, leader of the expedition, at the session of the Presidium of the Soviet Academy of Sciences held on August 25, 1961. For the first time it has been possible to obtain some details regarding the thickness, structure and relief of the earth's crust under the Indian Ocean. In studying the relief of the ocean floor several hitherto unknown submarine mountains and ranges have been discovered. Explorations have shown that rocks of volcanic origin occupy a large proportion of the bottom of this vast water basin. Investigations of composition and structure have revealed that in the southern part are present massive accumulations of iron-manganese ores containing up to 0.5% nickel, cobalt and other rare metals.

The fauna of the Indian Ocean is very varied and scientists on board the *Vityaz* have collected a large number of animals and fish living on

the ocean bottom, among which are many that are little explored or absolutely unknown. Study of the chemistry of water at different areas of the ocean has shown that the amount of oxygen in a greater part of the Indian Ocean is sufficient for the life of fishes and marine animals. The only exceptions are the Arabian Sea and the Bay of Bengal, where oxygen content drops to zero in some places. This is explained by insufficient vertical circulation of water in those areas. Here also the explorers detected large amounts of hydrogen sulphide. Promising fisheries have been discovered during the expeditions, specifically large tuna fisheries south of Indonesia.

The *Vityaz* expeditions were held under the international programme for the exploration of the Indian Ocean, and formed one of the first marking the beginning of further explorations of the Indian Ocean. *Vityaz* had twelve scientific teams of diverse interests functioning on board.—(USSR News.)

ON THE LOCATION OF SPAWNING GROUNDS OF INDIAN SHAD, *HILSA Ilisha* (HAMILTON) IN FRESHWATER REGIONS OF THE NARBADA RIVER

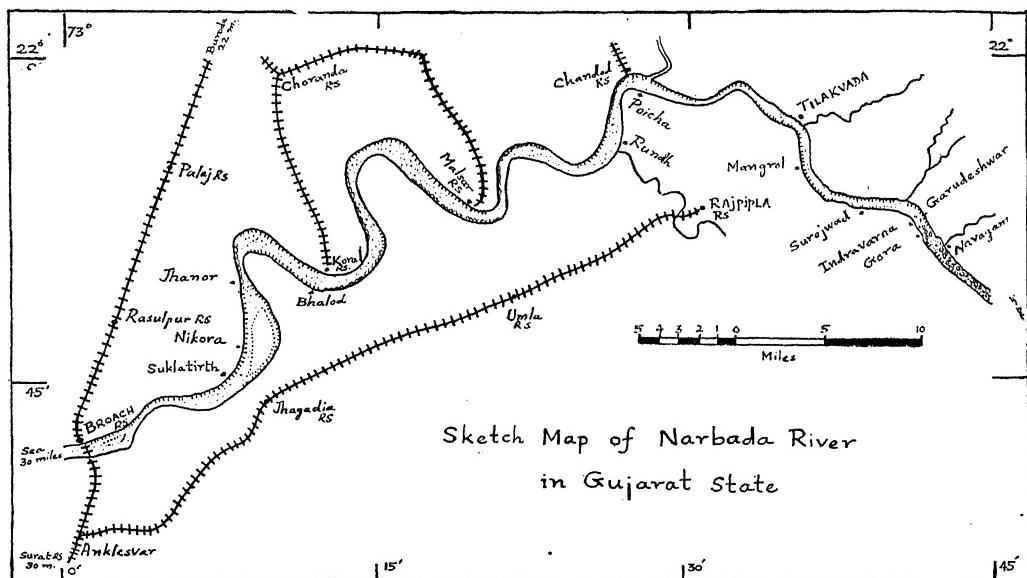
S. J. KARAMCHANDANI

Narbada-Tapti Survey Unit, Central Inland Fisheries Research Institute, Hoshangabad (M.P.)

WHILE upstream migration of *Hilsa ilisha* (Hamilton) in the Narbada river is reported up to tidal limit near Bhalod, about 50 miles from sea, a few shoals are known to penetrate freshwater as far as Gora which is about 100 miles from sea (see Fig. 1). Kulkarni¹ established spawning grounds of *Hilsa* in the Narbada river near tidal limits between Nicora and Jhanor villages (about 40 miles from sea), but the spawning activities of *Hilsa* have not hitherto been recorded from freshwater regions of the Narbada river. The present note furnishes evidences collected during summer monsoon seasons of 1959 and 1960, on the spawning of *Hilsa* within freshwater regions of the Narbada river, immediately below Gora, the known uppermost limit of *Hilsa* migration. These observations are of significant importance in view of the construction of the proposed dam across the Narbada near Navagam in Broach district of Gujarat State about 2 miles upstream of Gora.

eggs were collected at Poicha from 2-7-1960 to 9-9-1960, about 15,000 eggs at Malsar from 29-7-1960 to 19-9-1960 and 26 eggs at Mangrol from 15-7-1960 to 30-7-1960.

Three batches of *Hilsa* eggs, each numbering 700 to 800, were successfully reared in the field laboratory up to 8, 13 and 14 days after hatching. Descriptions of developmental stages of *Hilsa* agree with the earlier accounts of Kulkarni,¹ and Jones and Menon² barring a few differences. Optic vesicles and auditory capsules observed by Kulkarni in newly hatched larva and second-day larva respectively were discerned in the embryonic stages in the present case and as observed by Jones and Menon. According to Kulkarni, and Jones and Menon, the newly hatched larva measured 3.1 mm. and 2.3 mm. respectively but in the present case the average length of newly hatched larva was found to be 2.65 mm. (Range: 2.4-3.0 mm.). The larval stage (measuring 6.5 mm.) with trace of yolk and thickening in dorsal fin region, given by



By operating spawn collection nets in shallow areas of the river during summer monsoon months, approximately 35,000 developing *Hilsa* eggs were collected at Poicha centre from 8-7-1959 to 19-8-1959 and none at Indravarna centre in 1959 season; and about 20,000 *Hilsa*

Jones and Menon, is referable in the present study to the larval stage of tenth day measuring 5.8 mm. On the basis of growth rate in larval stages, Jones and Menon assumed that 8.0 mm. long post-larval stage, with constriction in fin fold behind the dorsal fin, is attained in about

a week but in the present study post-larval stage attained the average length of 6.05 mm. (Range: 5.8-6.2 mm.) in two weeks and did not have constriction behind dorsal fin.

The availability of fertilised eggs and the occurrence of mature *Hilsa* in the commercial catches in the river in 1960 season have shown that the spawning season of *Hilsa* commenced in June-July and continued up to September, the peak of spawning season being in the month of August, when the river was flooded to the maximum (mostly 20'-48'). The observations on the age of developing eggs and the time of their collection indicated that the spawning took place mostly in the afternoon and evening from 2.00 p.m. to 6.00 p.m. The occurrence of *Hilsa* eggs in abundance, which is concomitant with upstream migration of large shoals of *Hilsa*, was found to have relation with lunar periodicities, as the peak collections of *Hilsa* eggs were made during spring tide from 2nd to 4th day and 10th to 12th day after new moon or full moon. The extensive *Hilsa* fishing which was observed in Narbada river on these days also supports this observation. Kulkarni¹ also observed that 'in Narbada river, *Hilsa* is caught on large scale only during spring tide especially from 12th day of each lunar fortnight up to 1st or 2nd day after full moon or new moon'. The observations on the availability of *Hilsa* eggs in relation to fluctuations in water level in the river have shown that when the water level was on the decrease in the upper reaches of the river on 2nd to 4th day and 10th to 12th day after new moon and full moon, the upstream migration and, in consequence, the spawning activities were delayed by few days till the water level in the river began to rise. Jones and Sujansinghani,³ Chacko and Dixithulu⁴ and Kulkarni⁵ have also indicated relationships of flood-water with *Hilsa* migration in Chilka lake, Godavari river and Narbada river respectively. The sex ratio in ascending males and females, caught in the vicinity of Broach, was found to be about 3.5 : 1 in the beginning of the spawning season (July) and nearly 1 : 1 during spawning season (August and September). This tends to show that the males ascend to spawning grounds earlier than the females.

The occurrence of large number of developing eggs of *Hilsa* at Malsar and Poicha centres and few at Mangrol centre in 1960 season has indicated that a stretch of 18-20 miles of the river between Poicha and Indravarna constitutes the spawning grounds of *Hilsa* and these observations are in agreement with those of

1959 season. In 1960 season, most of the *Hilsa* eggs collected during morning hours (8-00 a.m. to 11-00 a.m.) at Mangrol, Poicha and Malsar centres were approximately 3, 10 and 19 hours old respectively and few eggs collected during evening hours (2-00 p.m. to 5-00 p.m.) at Malsar centre were 8-10 hours old. The rate of drifting of the eggs along the river bottom has been roughly estimated to be about 1.75 miles per hour, the velocity of surface water being mostly 2 to 5 miles per hour during the period under observation. These observations have pointed out that stray eggs collected at Malsar in the evening hours would have drifted down from minor spawning grounds located in the vicinity of Poicha about 15 miles upstream of Malsar and majority of eggs collected during morning hours at three centres from the main spawning grounds situated few miles below Indravarna in the vicinity of Surejwad fishing village which is about 5, 17 and 33 miles upstream of Mangrol, Poicha and Malsar. These observations are also supported by the fact that the active *Hilsa* fishing was in progress in this area (between Poicha and Indravarna) where *Hilsa* had evidently migrated for spawning. In fact this stretch is reported to be the only regular *Hilsa* fishing area in the freshwater though of minor importance, the other regular fishing centres of major importance being in the tidal area.

The analyses of length-frequency data of *Hilsa* from tidal zone and freshwater zone separately have shown that while all size groups of ripe *Hilsa* (males 265-605 mm.; females 295-605 mm.) occurred in tidal zone, only older *Hilsa* (males 315-485 mm.; females 415-555 mm.) migrated to freshwater areas. It is thus significantly interesting that younger (probably two-year old) ripe *Hilsa* (males 265-315 mm.; females 295-415 mm.), which were encountered in abundance in tidal areas, were totally absent in the freshwater areas, indicating the upstream migration of only older *Hilsa*. The independent observations of Pillay⁶ and Jhingran⁷ on length frequency of *Hilsa* also point out to long-range upstream migration of only older groups of *Hilsa* in the Gangetic system, as the former recorded the occurrence of ripe males and females in 160-430 mm. and 190-510 mm. size ranges respectively from Hooghly and the latter in 221-465 mm. and 325-485 mm. respectively from Ganga at Buxar (Bihar). From these observations, it appears probable that the younger *Hilsa*, perhaps maturing for the first time, ascend only up to tidal limit whereas the older *Hilsa* migrate higher up in freshwater areas for breeding. Southwell⁸ suggested (as

quoted by Sujansinghani⁹) that 'old *Hilsa* probably spawn in the high reaches of the river, while young *Hiisa*, more susceptible to changes involved in the transition from sea to the freshwater, probably spawn lower down the river'. Kulkarni⁵ also considered the possibility of differential upstream migration of the younger and the older size groups in Narbada river, but could not decide on the size group which ascends higher up in the river, as no data were available on this aspect.

From length-frequency data of *Hilsa* it is further observed that the largest *Hilsa* specimens, which were present in negligible number in the catches of tidal areas, were not encountered in the freshwater zones. While discussing the upper limit of *Hilsa* migration in Narbada river, Kulkarni⁵ stated that the migration of *Hilsa* is curtailed step by step in the stretch of 6-8 miles from Garudeshwar to Makhedi (the uppermost limit) due to swift currents and rapids in that stretch, but some *Hilsa* do cross the barrier at Makhedi. According to him, those *Hilsa* which usually cross this barrier are of larger size. In view of these observations of Kulkarni, it appears probable in the present case that the largest *Hilsa* (males 485-605 mm.; females 555-605 mm.), being comparatively very strong, migrated further up beyond Garudeshwar and were not available in the area of intensive fishing from where the samples were obtained for the present study.

The differential spawning behaviour of two runs of *Hilsa* in Narbada river and elsewhere, the one spawning near tidal limits and the other spawning higher up in freshwater, may be due to either varied nature of physiological changes occurring in the young and the old

Hilsa or the presence of two different races of *Hilsa*. The morphometric data for the samples from the tidal and the freshwater areas of Narbada river, which are awaiting detailed analysis, are expected to throw light on the latter aspect.

The length-frequency data have further shown that as compared to Gangetic *Hilsa*, the Narbada *Hilsa* attains first maturity at higher length (265 mm. ♂ and 295 mm. ♀) and is also of larger size (over 605 mm., both ♂ and ♀). The size variations in *Hilsa* stocks of Gangetic system and Narbada river may be entirely due to differences in the biological environments. The comparison of morphological characters of Narbada *Hilsa* with those of Gangetic *Hilsa* should throw light on this aspect of *Hilsa* stocks of the two river systems.

My grateful thanks are due to Dr. B. S. Bhimachar, Director and Dr. M. P. Motwani, Research Officer of Central Inland Fisheries Research Institute, for their valuable suggestions and constant encouragement and to Sarvashri M. D. Pisolkar, P. Das and P. K. Pandit of Narbada-Tapti Unit for their ungrudging assistance in the field.

1. Kulkarni, C. V., *Proc. Natnl. Inst. Sci. India*, 1950, **16** (3), 169.
2. Jones, S. and Menon, P. M. G., *Proc. Indian Acad. Sci.*, 1951, **28B** (3), 101.
4. Chacko, P. I. and Dixithulu, D. V. N., *Proc. 38th Indian Sci. Congr.*, 1951, Part 3, 227.
3. Jones, S. and Sujansinghani, K. H., *Journ. Bom. Nat. Hist. Soc.*, 1951, **50** (2), 264.
5. Kulkarni, C. V., *J. Asiatic Soc.*, 1954, **20B** (1), 47.
6. Pillay, T. V. R., *Indian J. Fish.*, 1958, **5** (2), 201.
7. Jhingran, V. G., *Ibid.*, 1957, **4** (2), 336.
8. Southwell, T., *Bull. Dept. Fish., Bengal, Bihar and Orissa, Calcutta*, 1914, **4**, 1.
9. Sujansinghani, K. H., *Indian J. Fish.*, 1957, **4** (2), 315.

AEROSOL LAYER IN THE STRATOSPHERE

STUDIES of nuclear fall-out distribution in the upper atmosphere carried out by analysis of air samples collected by high altitude balloons and aircrafts, have shown that there is present an aerosol layer 3 miles thick, consisting mainly of sulphur particles, enveloping the earth about 11 miles out in space. In analyzing the samples it was noticed that the concentration of sulphur was exceptionally large between altitudes of 11 and 14 miles. Detailed studies during the year undertaken by the Air Force Cambridge Research Laboratories U.S.A. have shown that the concentration of particles within the layer is about 16 per cubic inch which is three times the number at adjacent levels. These particles are between 0.1 and 2 microns in size. Electron microprobe analyses of samples showed the layer

is about 85% sulphur. Silicon, iron and aluminium were also found in some samples.

The aerosol layer is thought to originate at its observed location. Probably gases such as hydrogen sulphide or sulphur dioxide known to be present at lower altitudes, enter the stratosphere and are chemically changed either by sunlight or ozone.

The world-wide aerosol layer may at last provide an explanation for the twilight phenomenon known as purple light. This conspicuous red disk of light is frequently seen above the point of sunset or sunrise. A thick aerosol layer in the stratosphere could scatter light in such a way to produce just the phenomenon.—(J. Frank. Inst., 1961, 272, 84.)

LETTERS TO THE EDITOR

STUDY OF ASTRAL MOLECULES: INTENSITIES, FRANCK-CONDON FACTORS AND r -CENTROIDS OF THE BANDS OF BaO (${}^1\Sigma - {}^1\Sigma$) SYSTEM

QUANTITATIVE gross intensity study of the bands of BaO (${}^1\Sigma - {}^1\Sigma$) system excited in a flame from a specially designed burner has been made by rigorous methods of photographic photometry in the general programme outlined for the investigations of astral molecules in this laboratory. The results of intensities obtained by evaluating the area under the intensity contours of bands after the manner of Tawde and Patankar¹ and Tawde and Sreedhara Murthy² are entered in Table I for the system.

TABLE I
Integrated intensities
BaO (${}^1\Sigma - {}^1\Sigma$) system

Band v', v''	Intensity	Band v', v''	Intensity
0, 0	9.48	2, 0	54.3
0, 1	11.9	2, 1	100
0, 2	77.3	2, 2	17.4
1, 0	22.5	3, 0	54.4
1, 1	94.4	3, 1	30.7
1, 2	94.2	3, 3	31.8
		3, 4	12.9

These intensities have been used to arrive at the experimental Franck-Condon factors (I/v^4). The same have been computed theoretically by (a) Manneback's method under harmonic oscillator concepts and by (b) Bates' method of numerical integration, involving anharmonic oscillations. Comparative study of the results of the two theoretical methods between themselves and in relation to experimental data has been made. It gives better agreement of experimental results with the latter theory (b), as is to be expected.

Further, the data of the above numerical integration method of Bates has been compared with the recent theoretical computations of Ortenberg³ by (i) Bates' tabular method; (ii) Morse's simplified potential method and (iii) the method of r_c -shift. All these values have been found to be more or less in agreement among themselves. One expects, however, the results of numerical integration to be better representative of the transition probabilities.

The theoretical transition probabilities as obtained by Bates' numerical integration method have been further subjected to correction for the variation in electronic transition moment with internuclear distance. For this purpose, the r -centroids have been calculated by two methods, viz., (i) the direct method and (ii) the mean value method, given by Nicholls and Jarmain.⁴ Of these two methods, the results of the direct method are justified to be more accurate.

Using the above r -centroid values and the Franck-Condon factors as evaluated by Bates' method, the relation between $R_c(r)$, the electronic transition moment and r , the internuclear distance has been evolved according to the several procedures suggested by Nicholls⁵ and Turner and Nicholls.⁶ For the system of BaO under investigation, the relation takes the form

$$R_c(r) = \text{Const.} (1 - 0.536 r).$$

With this relation, the final smoothed transition probabilities have been derived. It is concluded that the degree of agreement between theory and experiment becomes double on introduction of anharmonicity into harmonic oscillator concepts and five times when anharmonic oscillations are further corrected for electronic moment variation. This establishes the significance of the latter in the concepts of the theories of vibrational transition probabilities.

The detailed results of this investigation are being reported elsewhere in the form of a full paper.

The author records his gratefulness to Dr. N. R. Tawde, the Head of the Department of Physics, for suggesting the problem and for his constant guidance.

Department of Physics,
Karnatak University,
Dharwar (Mysore State),
India, June 26, 1961.

A. P. WALVEKAR.

1. Tawde, N. R. and Patankar, V. S., *Proc. Phys. Soc.*, 1943, **55**, 396.
2. — and Sreedhara Murthy, N., *Proc. Ind. Acad. Sci.*, 1960, **61**, 219.
3. Ortenberg, F. S., *Optics and Spectroscopy*, 1960, **9**, 82.
4. Nicholls, R. W. and Jarmain, W. R., *Proc. Phys. Soc.*, 1956, **69 A**, 253.
5. —, *Ibid.*, 1956, **69 A**, 741.
6. Turner, R. G. and Nicholls, R. W., *Canad. J. Phys.*, 1954, **32**, 475.

POTENTIAL CONSTANTS AND
THERMODYNAMIC PROPERTIES OF
 SiBr_3I

THE molecules of the type XY_3Z whose normal vibrations have been studied by Meister and Cleveland¹ on the basis of Wilson's group theoretical method,² have the symmetry point group C_{3v} and on the application of relevant selection rules³ give rise to three non-degenerate A_1 type vibrations and three degenerate E type vibrations. All are allowed both in Raman as well as infra-red absorption spectra.

The fundamental frequencies of SiBr_3I studied by Dalwaille and her co-workers⁴ occur at 120 cm^{-1} (A_1), 225 cm^{-1} (A_1), 443 cm^{-1} (A_1), 79 cm^{-1} (E), 127 cm^{-1} (E) and 487 cm^{-1} (E). Using these frequencies in cm^{-1} , considering the bond distances $\text{Si}-\text{I} = 2.45 \text{ \AA}$ and $\text{Si}-\text{Br} = 2.19 \text{ \AA}$ and assuming all the angles as tetrahedral, the potential constants on the basis of Wilson's group theoretical method have been calculated. Some of the interaction constants are borrowed from the related molecules and the values of other constants are systematically adjusted so that the obtained force constants reproduce the observed fundamental frequencies to the nearest wave number. The values of the constants in 10^5 dynes per cm. are given below:

$$\begin{aligned} f_b &= 2.0113; \quad f_d = 2.4257; \quad f_{bd} = 0.2832; \quad f_{dd} = \\ &0.1534; \quad f_{d\theta} = 0.1522; \quad f_{d\phi} = 0.2614; \quad f_\theta - f_{\theta\theta} = \\ &0.2025; \quad f_\phi - f_{\phi\phi} = 0.1533; \quad f_{d\theta} + f_{d\phi} = 0.1038; \\ &f_{\theta\theta} + f_{\phi\phi} = -0.0515 \text{ and } f_\theta + f_\phi = 0.3043. \end{aligned}$$

Using the above fundamental frequencies in cm^{-1} of SiBr_3I , the thermodynamic properties such as heat content, free energy, entropy and heat capacity were calculated for the temperature range from 50° to $1,600^\circ\text{K}$. A rigid rotator, harmonic oscillator model was assumed and the values were calculated for the ideal gaseous state at one atmospheric pressure. Using the above parameters the moments of inertia calculated are given below:

$$\begin{aligned} I_{xx} &= I_{yy} = 1255.9636 \text{ AWU } \text{\AA}^2 \\ &\quad (2086.3188 \times 10^{-40} \text{ g. cm.}^2) \\ I_{zz} &= 1022.1576 \text{ AWU } \text{\AA}^2 \\ &\quad (1697.9367 \times 10^{-40} \text{ g. cm.}^2) \end{aligned}$$

The symmetry number is 3. The values obtained for the thermodynamic properties of SiBr_3I are given in Table I.

The author wishes to express his grateful thanks to Dr. K. Venkateswarlu for his constant encouragement and interest during the progress of this work, and to the University Grants Commission, Government of India, for the award of a post-graduate research scholarship.

TABLE I

Heat content, free energy, entropy and heat capacity of SiBr_3I for the ideal gaseous state at one atmospheric pressure*

T (°K.)	$(H_0 - E_0^\circ)/T - (F_0 - E_0^\circ)/T$	S°	C_p°
50	9.617	54.002	12.960
100	12.519	61.606	17.306
150	14.547	67.087	19.753
200	16.085	71.507	21.468
273.16	17.747	76.747	23.036
298.16	18.213	78.369	23.393
300	18.233	78.436	23.415
400	19.673	83.957	24.354
500	20.642	87.379	24.843
600	21.384	92.256	25.127
700	21.936	95.649	25.309
800	22.352	98.548	25.423
900	22.701	101.157	25.508
1000	23.005	103.84	25.570
1100	23.220	105.829	25.612
1200	23.450	108.066	25.650
1300	23.594	109.658	25.674
1400	23.751	111.599	25.696
1500	23.863	113.284	25.712
1600	23.998	114.828	25.727

* T is the temperature in degrees Kelvin, the other quantities are in cal. deg^{-1} mole $^{-1}$ and E_0° is the energy of one mole of perfect gas at absolute zero temperature.

Department of Physics, G. NAGARAJAN:
Annamalai University,
Annamalainagar (South India),
July 10, 1961.

1. Meister, A. G. and Cleveland, F. F., *J. Chem. Phys.*, 1950, **18**, 346.
2. Wilson, E. B. Jr., *Ibid.*, 1939, **7**, 1041; *Ibid.*, 1941, **9**, 76.
3. Herzberg, G., *Infrared and Raman Spectra of Polyatomic Molecules*, Van Nostrand Co., Inc., New York, 1945.
4. Dalwaille, M. L., Francois, M. F. and Buisset, M. D., *J. Phys. Radium.*, 1954, **15**, 206.

EVALUATION OF THE DIAMAGNETIC ANISOTROPY OF BENZENE FROM THE SUSCEPTIBILITIES OF SOME CARBOCYCLIC COMPOUNDS

CYCLOHEXANE, cyclohexene, cyclohexadiene, and benzene form a regular sequence of carbocyclic compounds with six carbon atoms in the ring. The second, the third and the fourth members of this sequence may be considered to be obtained from the one preceding these, by the removal of two hydrogen atoms and the conversion of one C—C bond into a C=C linkage. This regular step-wise change in the structure may be expected to be reflected in the magnetic properties of these compounds and the gram-

molecular susceptibilities (χ_m) ought to show corresponding regular variations. These susceptibilities are given in Table I, for comparison. The values have been taken from Pascal's work quoted in *International Critical Tables*. Although the recent accepted value of χ_m for benzene is slightly lower than the one given here, it is not being used because similar revised data on the other substances are not available. It is felt, however, that the arguments being presented in this note will remain unaffected by a revision of these values.

TABLE I
Values of the diamagnetic susceptibilities of some carbocyclic compounds

	$-\chi \times 10^6$	$-\chi_m \times 10^6$	$-\Delta \chi_m \times 10^6$
Cyclohexane	0.810	68.18	
Cyclohexene	0.711	58.39	9.79
1 : 3 Cyclohexadiene	0.607		
1 : 4 Cyclohexadiene	0.608	48.67*	9.72
Benzene	0.712	55.67	

* Mean of the two values for 1 : 3 and 1 : 4 cyclohexadienes.

It can be seen from the values given in Table I that the numerical decrease in the value of χ_m in going from the first to the second and from the second to the third compound is almost the same and the mean value of these two decrements is 9.76 units. If this reduction is associated with the change in the structure, namely, removal of two hydrogen atoms and the conversion of one C—C bond into a C=C linkage the gram molecular susceptibility of benzene should be expected to be -38.91×10^{-6} . The observed value is numerically larger than this by 16.76×10^{-6} . The only reason for this enhanced diamagnetism appears to be the presence of alternate single and double bonds between the carbon atoms of the ring, resulting in the complete delocalization of the π electrons. It is an accepted fact¹ that these π electrons are responsible for the high diamagnetic anisotropy of the benzene molecule. The point of present interest, therefore, is the conclusion that the contribution of the π electronic ring orbits to the susceptibility of liquid benzene is -16.76×10^{-6} and that the remaining part of the observed value of χ_m , i.e., -38.91×10^{-6} , is due to the rest of the molecule. If it is assumed that the anisotropy is entirely due to the ring orbits, then the contribution of the rest

of the molecule can be considered to be isotropic. This leads to the result that the molecular susceptibilities (K_1 and K_2) in the plane of the ring should be equal to -38.91×10^{-6} . Again, since $\chi_{ave} = K_{ave} = 1/3 (K_1 + K_2 + K_3)^2$, the diamagnetic anisotropy, $\Delta K (= K_3 - K_1)$ comes out to be -50.28×10^{-6} .

The values of the principal molecular susceptibilities of benzene and the anisotropy evaluated above are given in Table II for comparison with the results from other sources.

TABLE II
Principal molecular susceptibilities and the diamagnetic anisotropy of benzene

	Present work	Pauling ²	Krishnan, Guha and Banerjee ³
$-K_1 (= K_2) \cdot 10^6$	38.91	39	37.3
$-K_3 \cdot 10^6$	89.19	88.2	91.2
$-\Delta K \cdot 10^6$	50.28	49.2	53.9

It will be observed that the results of the present evaluation are in good agreement with the theoretical values obtained by Fauling⁴ and also with the estimates of Krishnan, Guha and Banerjee⁴ obtained from the magnetic birefringence and light-scattering data.

It is possible to evaluate the radius of the benzene ring with the help of Langevin's theory of diamagnetism and the value of ΔK . Adapted to this case, the theory gives

$$\Delta K = -\frac{Ne^2}{4mc^2} \sum r^2 = -4.248 nr^2 \times 10^{10}.$$

Here, the symbols have their usual meanings and n is the number of π electrons in the molecule. Taking $n = 6$ and $\Delta K = -50.28 \times 10^{-6}$, the value of 'r' comes out as 1.405 \AA . This value of the radius of benzene ring compares nicely with the accepted value of the C—C distance, $1.39 \pm 0.02 \text{ \AA}$, of this molecule.⁵

Physics Department,
Osmania University,
University College of Science,
Hyderabad-7, July 20, 1961.

V. T. DESHPANDE.
K. G. PATHAKI.

1. Selwood, P. W., *Magnetochemistry*, 1956, p. 112.
2. —, *Ibid.*, 1956, p. 119.
3. Pauling, L., *J. Chem. Phys.*, 1936, 4, 463.
4. Krishnan, K. S., Guha, B. C. and Banerjee, S., *Phil. Trans. Roy. Soc.*, 1933, 231 A, 235.
5. Wells, A. F., *Structural Inorganic Chemistry*, 1950, p. 512.

STACKING FAULTS IN A GOLD-CADMIUM ALLOY ($\text{Au}_{80}\text{Cd}_{20}$)

THE incidence of deformation stacking faults on cold working metals and alloys with close-packed crystal structures has frequently been investigated in the recent past.¹ The data available so far seem to suggest that the fault parameter (α) defined as the probability of finding a deformation fault on any close-packed plane may be large for metals and alloys which undergo a phase transformation from the face-centred cubic (f.c.c.) to the hexagonal close-packed (h.c.p.) structure on cooling or heating and hence have nearly the same free energies for these two structures at room temperature. This suggestion has been supported by work on h.c.p. cobalt² and cobalt-nickel alloys.³ A fault parameter of 0.075 was obtained for filings of pure cobalt which undergoes the f.c.c.-h.c.p. transformation martensitically from about 420°C. on cooling. This value was found to increase to 0.145 for a cobalt-22% nickel alloy having a lower phase transformation temperature than cobalt.

High stacking fault densities as above have not been measured for any f.c.c. structure in the deformed state. Oscillation photographs of a cold-worked copper-10% silicon alloy seem to suggest heavy faulting in the f.c.c. phase which transforms to the h.c.p. structure by a nucleation-and-growth mechanism at about 650°C. on slow cooling, but remains untransformed on rapid cooling.⁴ Considerable broadening of X-ray reflections has also been observed and attributed to stacking faults in several f.c.c. as well as h.c.p. gold-cadmium alloys.⁵⁻⁷ There is need, however, for quantitative experimental work on alloys undergoing the f.c.c.-h.c.p. transformation on slow cooling and capable of existence in the f.c.c. phase on rapid cooling to room temperature. Hence a detailed study of some selected alloys, e.g., gold-20% cadmium, silver-11% tin and the afore-mentioned copper-10% silicon, was started by us recently. The aim of our investigations is not only to check whether the expected high density of stacking faults is actually observed in fresh filings of these alloys, but also, to confirm whether the fault parameter varies markedly with the extent of deformation as reported earlier for brass filings.⁸

We examined sieved filings of the $\text{Au}_{80}\text{Cd}_{20}$ alloy in the cold-worked and annealed conditions by taking Debye-Scherrer patterns with Cu K_α radiation in the Nonius-Guinier camera with a bent crystal monochromator and obtaining profiles of the 111- and 200-reflections

through a Joyce automatic recording microdensitometer. As expected, the reflections from the cold-worked alloy displayed marked broadening as also a striking shift of the peaks in opposite directions (Fig. 1). The deformation fault parameter (α) was determined by measuring the change in separation in degrees between the peaks of the two reflections from the annealed to the deformed state using the equation⁹

$$\Delta 2\theta = \frac{\pm \tan \theta \cdot \cos^2 \phi \cdot 270}{\pi^2 \cdot h_3} \sqrt{3 \cdot a},$$

where $\Delta 2\theta$ is the shift in peak for the hkl -reflection, ϕ is the angle between the reflecting normal and planes containing deformation faults and h_3 is $|h + k + l|$. Fresh filings having a grain size lower than 0.06 mm. were found to have a fault parameter of 0.087, i.e., one stacking fault on the average for every 12 close-packed planes. This represents the highest stacking fault density so far recorded for a deformed f.c.c. structure.

The profile of the 111-reflection for the fresh filings (Fig. 1) shows a prominent step at a lower angle which is identical with the Bragg angle of the 1010-reflection of the corresponding h.c.p. structure. This has been predicted⁷ for high stacking fault densities as the broadening in the L direction in the common reciprocal lattice for f.c.c. and h.c.p. structures has to end at zero L value for this reflection.

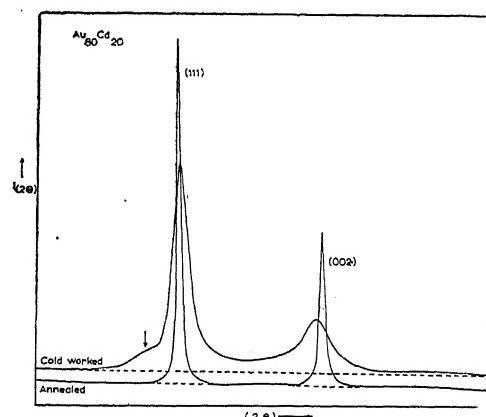


FIG. 1. Photometric record of the 111- and 200-Debye-Scherrer reflections for a gold-20% cadmium alloy in the annealed and cold-worked states (Nonius-Guinier camera; Cu K_α X-radiation).

For filings of a large grain size, viz., > 0.22 mm., the X-ray line broadening was definitely less and the faulting parameter was only 0.060. This result confirms the earlier

observation on brass filings. The difference between the two recorded fault parameters, viz., 0.087 and 0.060, is large enough to indicate a definite contribution of inhomogeneous distribution of stacking faults in filings of mixed grain size to any observed asymmetry of line profiles. This fact should not be ignored in attributing any such asymmetry in line profiles to the formation of growth or twin stacking faults as well on deformation.¹⁰

The authors are grateful to Dr. M. Wilkens of the Max-Planck-Institut fuer Metallforschung, Stuttgart, West Germany, for assistance in the experimental work and for stimulating discussions.

Dept. of Metallurgy,
Indian Inst. of Sci.,
Bangalore-12, September 25, 1961.

P. RAMA RAO.

T. R. ANANTHARAMAN.

1. Anantharaman, T. R., Christian, J. W., Pargeter, F. W. and Spreadborough, J., *Trans. Ind. Inst. Metals*, 1960, **13**, 119.
2. Anantharaman, T. R., *Ibid.*, 1960, **13**, 374.
3. Spreadborough, J., *Acta Cryst.*, 1960, **13**, 603.
4. Barrett, C. S., *Trans. Amer. Inst. Min. Met. Eng.*, 1950, **188**, 123.
5. Massalski, T. B., *Acta Met.*, 1957, **5**, 541.
6. Wegst, J. and Schubert, K., *Z. Metallkunde*, 1958, **10**, 533.
7. Wilkens, M., *Acta Cryst.* (in press).
8. Anantharaman, T. R., *Acta Met.*, 1961, **9**, 109.
9. Warren, B. E. and Warekois, E. P., *Ibid.*, 1955, **3**, 473.
10. Wagner, C. N. J., *Ibid.*, 1957, **5**, 427 & 477.

PHOTOLYTIC PREPARATION OF URANIUM (IV) SULPHATE COMPLEXES

GREEN compounds are obtained when photolysis of uranyl ion in presence of ammonium sulphate and alcohol is carried out in sunlight. These products being highly soluble are different from uranium (IV) oxysulphate UOSO_4 obtained by the same method reported earlier.¹ This behaviour suggested clue to the formation of complex compounds of uranium (IV) oxy sulphate with ammonium sulphate. The moist compounds have been used for the analyses of the constituents, namely total uranium, uranium (IV), ammonium and sulphate contents, according to standard methods.

The compound obtained by the photolysis of uranyl sulphate and ammonium sulphate taken in the ratio of 1:8 is found to contain U^{4+} , NH_4^+ , and SO_4^{2-} in the ratio of 1.00:1.50:1.75. So the compound has been assigned the formula $2\text{UOSO}_4 \cdot 1.5 (\text{NH}_4)_2\text{SO}_4 \cdot n\text{H}_2\text{O}$. However, a different compound is formed when photolysis is carried out with uranium and ammonium sulphate in the ratio of 1:16. On

analysis, U^{4+} , NH_4^+ and SO_4^{2-} have been found to be present in the ratio of 1.00:2.00:2.00. so the formula $\text{UOSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ has been assigned to this complex.

Sodium and potassium complexes have been prepared by the same method of photolysis. The compound $\text{UOSO}_4 \cdot 0.75 \text{Na}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ is obtained when the ratio of uranyl sulphate to sodium sulphate is 1:4, but with the ratios of 1:8, 1:12 and 1:16, the complex $\text{UOSO}_4 \cdot \text{Na}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ is isolated. Two potassium complexes, namely $\text{UOSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ and $\text{UOSO}_4 \cdot 1.75 \text{K}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ have been prepared when uranyl sulphate and potassium sulphate are taken in the ratio of 1:8 and 1:12 respectively.

Attempts for preparing these compounds by conventional methods such as crystallisation and solvent exchange proved unsuccessful.

Department of Chemistry, U. K. DAS.
Ravenshaw College, S. K. PUJARI.
Utkal University, BALARAM SAHOO.
Cuttack, April 3, 1961. D. PATNAIK.

1. Sahoo, B. and Patnaik, D., *J. Ind. Chem. Soc.*, 1959, **36**, 483.

STUDY OF THE REACTION OF MANDELIC ACID WITH SODIUM MOLYBDATE AND SODIUM TUNGSTATE

MANDELIC acid has been known to be used for the detection of certain elements like copper.¹ A survey of the literature has shown meagre references wherein mandelic acid has been used as a complexing agent. The authors have, therefore, taken up the reaction of mandelic acid with sodium molybdate and sodium tungstate with a view to ascertaining their stoichiometric ratio by using physico-chemical methods like pH and conductance.

All the reagents employed were of B. D. H. Analar variety. Sodium molybdate and sodium tungstate were analysed by the usual methods and the analyses established their formulæ as $\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ and $\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$ respectively. Various solutions were prepared by dissolving them in double distilled water. Doran's conductivity bridge with a WTW oscillator was used for conductance measurements and Beckmann pH meter model G-2 with standard calomel and glass electrode was used for the pH measurements. The temperature of all the solutions was maintained at $28 \pm 0.1^\circ\text{C}$.

To arrive at the stoichiometry, the monovariation method² was used. This method was utilised in the following way. To 5 ml. of sodium molybdate and sodium tungstate varying amounts

of mandelic acid were added and the total volume was always made up to 30 ml. with distilled water. The solutions were left for about twelve hours to attain equilibrium. Conductivity and pH of the solutions were then measured for various concentrations of all the solutions. Taking conductance or pH as abscissa and the amount of ligand used as ordinate graphs were plotted. In all the cases a clear break is obtained which corresponds to the ratio 1 : 2.

Hence it is found that both sodium molybdate and sodium tungstate form a 1 : 2 complex with mandelic acid. This was further confirmed by Job's method of continuous variation.^{3,4} Three different compositions of all the solutions, viz., M/80, M/100 and M/120 were used. Blank experiments under similar conditions were performed with the metal solution and ligand solution separately. The divergence from the additivity rule was plotted against the composition and the maxima in all the cases correspond to 0.66. This firmly establishes the stoichiometry of both the complexes at 1 : 2.

The authors express their gratitude to Prof. A. K. Bhattacharya for his keen interest evinced in the present work and to the U.G.C. for awarding a research scholarship to one of them (S.P.B.).

Chemical Laboratory, S. P. BANERJEE,
University of Saugar, ARUN K. BHATTACHARYA,
Saugar (M.P.), June 5, 1961.

- Deniges, G., *Bull. trav. soc. pharm. Bordeaux*, 1939, **77**, 148.
- Nayar, M. R. and Pande, C. S., *Proc. Nat. Acad. Sci.*, 1948, **27**, 284.
- Job, P., *Compt. Rend.*, 1925, **180**, 928.
- Kachhwaha, M. S., and Bhattacharya, Arun K., *Z. anorg. allg. chem.* (communicated).

ORGANIC ACID METABOLISM IN TAMARIND LEAVES

THE only organic acids in the leaves and fruits of the tamarind tree are the optically active *d*-tartaric and *l*-malic acids.¹ The seasonal variation of tartaric acid in tamarind leaves has been reported by us earlier²; the studies have now been extended to *l*-malic acid also. Leaf sap, instead of whole leaves, was used this time, since this is recommended to give a composite sample representative of the solution of total soluble organic acids in the normal living system.³ The studies on seasonal variation of the acids in the leaf sap and a few metabolic experiments on isolated leaves reported here indicate that the acids synthesised in the leaves

are primarily translocated to the growing berries, with little or no metabolic utilization.

Leaf sap was prepared by grinding freshly plucked leaves in a triple-roller mill and then pressing in a carver press. Aliquots of the clear juice obtained on centrifugation of the extract were used for determination of *d*-tartaric and *l*-malic acids according to methods⁴ based on A.O.A.C. procedures for these acids in fruit juices.⁵ All samples of leaves were taken from a healthy tree in the Institute premises.

The changes in acid concentration in the leaf sap from April through March are graphically shown in Fig. 1. The preponderance of tartaric over malic acid almost throughout the year is obvious; only towards the end, in winter, the malic acid content becomes comparable to that of tartaric acid. There is a gradual rise in the pH of the sap from 2.3 to 4.1 as the tartaric acid content decreases. An additional reason for this shift in pH is the absorption of calcium and potassium which partially neutralise the acids forming acid salts.² A major portion of the acid tartarates remains behind fixed in the leaves because of low solubility.

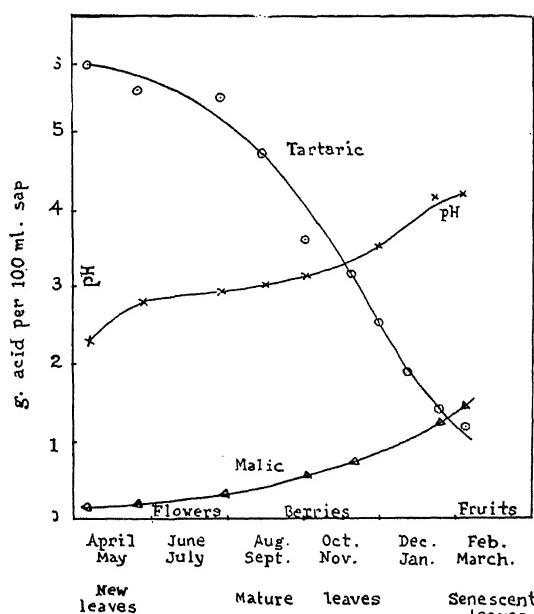


FIG. 1. Seasonal variation in pH and tartaric and malic acid content of tamarind leaf sap. The progressive appearance of flowers, berries and fruits on the one hand and new leaves, mature leaves and senescent leaves on the other are indicated along the horizontal axis at the corresponding months of the year.

Analysis of leaves picked early in the morning and late in the evening at three different parts of the year did not show any significant change

in tartaric or malic acid content between morning and evening in a single day. This indicates the absence of any 'Crassulacean' type of metabolism.

Starvation experiments with excise leaves according to the technique of Pucher *et al.*⁶ did not show any change in tartaric acid content even after 72 hours. However, a slight decrease in malic acid was observed.

Respiratory quotients of leaves and flowers were determined using a simple eudiometric type respirometer (Ganong respirometer). The values for flowers approached unity (0.95) which is typical of many plants, but those for samples of leaves were abnormally low (0.75-0.78). Oxidation of malic and tartaric acids would result in R.Qs far greater than 1 (1.3-1.6).

Studies by Stafford and Loewus⁷ on grape leaf indicate that tartaric acid is formed in a secondary process from the primary carbohydrate products of photosynthesis. Fresh bright green foliage and long hours of sunlight in the summer are ideal for photosynthetic processes in the tamarind tree. The accumulation of large amounts of tartaric acid in the leaf sap during this season is very significant. The metabolic conversion of α -glucose to tartaric acid by removal of carbon atoms 5 and 6 and oxidation to dicarboxylic acid is suggested by Vickery and Palmer.⁸ Since oxaloacetate was found to be sluggishly oxidised by young tamarind leaves in respiratory studies, Ramakrishnan and Joshi⁹ have suggested that sugar gets converted to oxaloacetate through the operation of the tricarboxylic cycle enzymes and that oxaloacetate gets converted to tartrate via hydroxyfumarate. Whatever be the mechanism of such conversions, tartaric acid once formed cannot enter back into the metabolic cycle. The only known enzymes in higher plants which metabolise tartaric acid do not use the (+) isomer.⁷

That the origin of malic acid may be different from that of tartaric acid is indicated by the fact that, unlike tartaric acid, its concentration is very low in the new leaves and becomes comparable to tartaric acid only towards the end of the year. It is well known that the formation of malic acid by CO_2 fixation is optimal at low temperature and the observation, that the malic acid content of tamarind leaves becomes appreciable only in winter months is significant in this context.

The absence of any diurnal variation, the non-utilization of acids during starvation and low respiratory quotients all indicate little or no metabolic utilization of tartaric and malic

acids in the leaves, once they are formed. Translocation to the growing berries and fixation in the form of insoluble tartrates in older leaves account for most of the acids produced. The accumulation of acid to a high concentration at any stage only implies that the rate of production is higher than the rate of withdrawal.

The authors wish to thank the Director Dr. V. Subrahmanyam, and Dr. A. Sreenivasan for their interest in this work.

Central Food Technological Research Institute, Mysore, June 29, 1961.

Y. S. LEWIS.

S. NEELAKANTAN.

D. S. BHATIA.

1. Lewis, Y. S. and Neelakantan, S., *Food Sci.*, 1960, 9, 403.
2. — and —, *Curr. Sci.*, 1959, 28, 152.
3. Broyer, T. C. and Isaac, T. L., *Plant Physiol.*, 1942, 17, 69.
4. Lewis, Y. S., Neelakantan, S. and Bhatia, D. S., *Food Sci.*, 1961, 10, 49.
5. *Official and Tentative Methods of Analysis* (Assn. of Agri. Chem., Washington), 1955.
6. Pucher, G. W., Wakeman, A. J. and Vickery, H. B., *J. Biol. Chem.*, 1937, 119, 523.
7. Stafford, H. A. and Loewus, F. A., *Plant Physiol.*, 1958, 33, 194.
8. Vickery, H. B. and Palmer, J. K., *J. Biol. Chem.*, 1954, 207, 275.
9. Ramakrishnan, C. V. and Joshi, A. P., *Annual Technical Report, C.S.I.R.*, 1959-60, 218.

SEWAGE AND ACTIVATED SLUDGE AS CONVENIENT SOURCES FOR THE ISOLATION OF AZOTOBACTER AGILIS

BECAUSE of their role in the nitrogen economy of nature, *Azotobacter* species have received considerable attention with regard to their habitat and distribution. Bergey's Manual¹ seeks to recognize only three species, *viz.* *A. chroococcum*, *A. agilis* and *A. indicus* and refers to their habitat as respectively soils, water and soil, and soils. However, there is enough justification to conclude that there exist other species, *e.g.*, *A. insigne*, whose presence in water has been revealed during recent years.^{2,3} Thus it would appear that the distribution of *Azotobacter* species in nature is restricted more or less to soil and water.

The reported presence of *A. agilis* in sewage by Soriano⁴ and in strawboard waste water by Smit⁵ and Johnstone⁶ is of special interest in this connection, but unfortunately, Soriano's observation was limited to the isolation of only one strain. With a view, therefore, to see whether its isolation from sewage was a chance finding, enrichments were set up for isolating *Azotobacter* from sewage and activated sludge. It is of interest to mention here that activated

sludge is relatively rich in nitrogen and the presence of this bacterium therein or in sewage would not only help explain its possible role in the nitrogen status of the sludge but also in gaining an insight into the ecology of this organism.

For isolation purposes, an enrichment medium containing 0.5% each of sucrose and mannitol as carbon source was employed and was inoculated with either 1 ml. sewage or activated sludge. Details of the isolation procedure have been presented elsewhere.⁷ Examination of 21 samples of raw sewage and 9 samples of sludge resulted in the isolation of 24 cultures of *Azotobacter* of which 3 were characterized as strains of *A. chroococcum* and the remaining 21 as those of *A. agilis*. The recognition of *A. agilis* was based *inter alia* on the fact that they had peritrichous flagella, did not produce cysts and did not utilise mannitol. All the strains produced a green pigment when the medium contained suboptimal amounts of iron, but not when its adequacy was maintained in the medium. This is in conformity with past observations on *A. agilis*,^{8,9} though it must be pointed out here that the change in the colour of the pigment from green to violet has not been recorded before except by Schutter and Wilson.⁸ It is also of some interest to observe that flagellar stained preparations not infrequently revealed a tuft of flagella, a characteristic associated with *A. insigne*. Nevertheless we have referred to the flagellation as peritrichous as many of the cells did show a flagellar pattern that could be frankly recognised as such.

Whether the identity established for the dominant sewage *Azotobacter* be *A. agilis* or *A. insigne* is of lesser interest here when compared to the significance that must be attached to its occurrence therein. For, though sewage comprises of soil washings, only 3 cultures of *A. chroococcum* were isolated and no other soil forms were encountered. That this was not caused by the unsuitability of our medium was judged by the fact that the same medium, inoculated with soils, had resulted in the exclusive isolation of *A. chroococcum*; and, it was precisely for the enrichment of this species that a sucrose-mannitol medium was employed in all the experiments notwithstanding the observation that *A. agilis* was unable to use mannitol. Apparently, therefore, the former species is not suited to an aquatic nidus, while the latter finds even a highly polluted aquatic environment suitable. That *A. agilis* is able to survive against the legion of other bacteria

in an environ of this type is in itself interesting and reveals a new source for its ready isolation, not to mention the ecological implications of the finding under report.

The authors' thanks are due to Dr. S. C. Pillai and Dr. S. Bhagavantam of this Institute for their keen interest.

Fermentation Technology Lab., F. F. DIAS.
Indian Institute of Science, J. V. BHAT.
Bangalore, September 4, 1961.

1. Breed, R. S., Murray, E. G. D. and Smith, N. R., *Bergey's Manual of Determinative Bacteriology*, 7th Edition, The Williams & Wilkins Co., Baltimore, 1957.
2. Dexx, H. G., *Proc. Kon. Nederland. Acad. v. Wetensch.*, 1951, **54C**, 342.
3. Jensen, V., *Bot. Tidsskr.*, 1955, **52**, 143.
4. Soriano, S., *Science*, 1939, **89**, 563.
5. Smit, J., *J. Gen. Microbiol.*, 1954, **11**, vii.
6. Johnstone, D. B., *Ecology*, 1957, **38**, 156.
7. Dias, F. F., *M.Sc. Thesis*, Indian Inst. Sci., 1961.
8. Schutter, J. and Wilson, P. W., *J. Gen. Microbiol.*, 1955, **12**, 446.
9. Johnstone, D. B. and Fishbein, J. R., *Appl. Microbiol.*, 1957, **5**, 103.

ACETIC FERMENTATION OF MOLASSES

THE work outlined below formed part of the experiments done by the author on the production of acetic acid from molasses. On the same subject H. D. Sen in recent years had earlier published some work.^{1,2} The object here is to record some salient findings in connection with the acetic fermentation of molasses.

The procedure of the experiments briefly was as follows. Molasses solution of 20° Bx was clarified by boiling with lime and superphosphate. The clear, cooled solution was fermented with a pure culture of distillery yeast and at the end of fermentation the alcoholic wash was allowed to settle and become clear.

The culture of acetic bacteria was derived from the spontaneous fermentation of cane juice and worked in two acetifiers, one a 6-gallon wooden vessel and another a 45-gallon wooden cask, on the principle of the Quick Vinegar Process. In each of the acetifiers a middle zone between two perforated wooden discs, filled with wood shavings, formed the culture bed for the bacteria. The alcoholic wash was operated at 6 litres in the small acetifier and 15 gallons in the cask acetifier, mixed with a third of its volume of previously aceticified wash. During the circulation of the wash air from the laboratory compressor was admitted at a suitable rate into the chamber below the lower perforated disc. Ammonium sulphate was the only

nutrient employed. The acetifying wash, finding its way out, was collected and returned to the feeding tubs three times a day, and the feeding was so regulated that the wash undergoing acetification in each acetifier circulated through it once a day.

The results of a few of the experiments done are summarised in Table I. They indicate the following features.

of the small acetifier and to 69·6% in experiment 11 of the cask acetifier. In the latter acetifier the results in general were subject to some absorption losses and inadvertent leaks.

From a ton of molasses yielding 100 gallons of proof spirit or 57 gallons (*i.e.*, 452 lb.) of absolute alcohol, at least 354 lb. (60% yield) of acetic acid may be estimated to be produced in the wash. The distillation and purification

TABLE I

Expt. No. in the acetifier	Quantity of molasses wash taken	Acetified wash added	Water added	g. absolute alcohol per 100 c.c. in the alcoholic wash taken	g. ammonium sulphate	Period of acetification, days	Initial acidity, g. acetic acid per 100 c.c. total volume	Final acidity, g. acetic acid per 100 c.c. final volume	% Theoretical yield realised
<i>Small acetifier</i>									
34	6 litres	2 litres	..	5·66	3	8	1·80	5·85	66·3
35	"	"	..	6·31	Nil	9	1·83	6·24	65·7
36	8 litres	Nil	..	6·37	"	5	0·69	2·82	..
37	6 litres	2 litres	..	6·37	3	12	2·04	6·06	53·0
38	"	"	2 litres	6·59	3	8	1·62	5·70	73·5
39	"	"	"	6·59	3	6	1·56	5·52	73·3
<i>Cask acetifier</i>									
4	15 gls.	5 gls.	..	5·10	68	8	1·65	4·95	51·3
5	"	"	..	5·20	68	10	1·80	5·22	54·4
6	"	"	..	5·20	34	9	2·04	5·52	57·5
7	"	"	..	5·62	Nil	12	1·68	5·82	62·2
8	"	"	..	6·24	34	13	1·86	6·36	60·8
9	"	"	..	6·31	34	14	2·04	6·36	57·2
10	"	"	..	6·31	34	16	2·04	6·69	62·4
11	"	"	2 gls.	6·48	34	11	1·92	6·42	69·6

The final acidity reached in the wash equalled 5 to 6 g. acetic acid per 100 c.c., according to the alcoholic content of the molasses wash.

The period of acetification was considerably reduced on working the wash with water (*vide* experiments 38 and 39 in the small acetifier and experiment 11 in the cask acetifier). This points to the advantage of working diluted wash when delays occur in acetification.

When acetified wash was not used with the alcoholic wash (*vide* experiment 36), there was a set-back in acetification which therefore was incomplete, with some adverse consequences on the next experiment also. Acetified wash, when employed, served to dilute the alcohol concentration and hasten the acetification, while giving immunity to the culture by virtue of its acidity.

The net production of acetic acid in the wash, taking into account the initial and final volumes and the initial and final acid concentrations, worked out to 65% of the theoretical yield possible from the alcohol. Working diluted wash stimulated the activity of the bacteria and definitely increased the percentage yield. The yield thus rose to 73% in experiments 38 and 39

of the acetic acid are a different question. The acetified wash from good quality molasses, producible at about 800 gallons per ton, is hoped to serve as cheap vinegar.

The author thanks Messrs. Parry and Co., Ltd., for giving him opportunity to carry out the experiments.

Masulipatam,
August 30, 1961.

B. G. KRISHNAMURTI.

1. Sen, H. D., *Proc. Sugar Tech. Assoc.* (9th Annual Convention), 1940.
2. —, *Annual Rev. of Biochem. and Allied Res. in India*, 1943, 14, 93.

HEAVY ACCESSORY STUDY OF THE SANDS OF CAPE COMORIN

THIS note reports the results of a preliminary study of the heavy mineral assemblage of the sands collected from the beach sands of Cape Comorin, Madras State. A tract of nearly seven miles, extending from Nagercoil up to Cape Comorin, along the beach is found enriched in mineralised sands. The minerals occurring in

the sands are mostly, ilmenite, monazite, zircon and garnet.

Systematic sampling was made from the offshore, seaward up to the low-tide mark and the samples collected were mostly bulk samples. As the sands show a remarkable variation in the direction of the slope of the shore, the above method of collecting bulk samples was resorted. Six representative bulk samples were collected for the purpose of heavy mineral study. The study includes heavy mineral analysis, shape and size analysis.

HEAVY MINERAL STUDY

The method is mainly modelled on the lines suggested by Groves.¹ The six samples chosen for the study of heavy minerals cover a wide range of mineral composition and coarseness. The mounting of heavy crop separated by bromoform for microscopic study was done in methylene iodide of refractive index 1.74, after the method of Tatarsky.² Counts of not less than 800 grains per slide were made for the purpose of frequency estimations.

MINERAL CONSTITUTION OF SANDS

Sample No. 1.—It is mostly an ilmenite-garnet sand. The individual minerals are not well sorted and most of the heavy minerals are angular to subangular in shape. The heavy minerals are constituted by : Ilmenite (46.24%) ; Garnet (13.58%) ; Zircon (20.03%) ; Monazite (5.16%) ; Pyroxene (7.43%) ; Kyanite (1.29%) ; Tourmaline (1.86%) and Rutile (1%).

Sample No. 2.—It is essentially an ilmenite-zircon-garnet sand and the minerals are constituted both by sorted and unsorted ones. In this many ilmenite grains are subrounded. The minerals constituting the suite are : Ilmenite (85.52%) ; Zircon (5.72%) ; Garnet (3.49%) ; Monazite (0.71%) ; Pyroxene (0.66%) ; Kyanite (0.84%) ; Rutile (0.71%) and Amphibole (0.42%).

Samples No. 3 and 4.—They are essentially ilmenite-zircon sands. Garnets become very scanty, while the zircons become abundant, and monazite becomes conspicuous. The peculiarity of these samples is, that they are fairly well sorted, though many of the zircons maintain their well defined crystal outlines. The heavy minerals comprising the samples are : Ilmenite (76.49%) ; Zircon (14.76%) ; Monazite (7.1%) ; Pyroxene (1.41%) ; Amphibole (0.84%) ; Rutile (0.80%) ; Kyanite (0.35%) and Brookite (0.38%).

Samples No. 5 and 6.—These samples are essentially ilmenite-monazite sands, though zircon is found in appreciable quantities. The

remarkable feature noticed in these samples is the typical egg-shape of monazite and zircons exhibiting well-defined zoning. The sorting is medium, as compared to the previous samples. The heavy minerals composing the above samples are : Ilmenite (73.87%) ; Monazite (14.49%) ; Zircon (12.30%) ; Rutile (0.96%) ; Staurolite (0.11%) and Garnet (0.91%).

The heavy minerals that constitute the assemblage of the sands of Cape Comorin, in the order of abundance are : ilmenite, zircon, monazite, garnet, rutile, kyanite, pyroxene, amphibole, tourmaline, zoisite, epidote, andalusite, sillimanite and brookite, of which the first four form the bulk and the rest are accessory in character.

The variation of the heavy minerals in the samples 1 to 6 is represented in Range Table I, after B.O.C. geologist's method.³ Samples 1 to 3 are distinguished by a more heterogeneous assemblage of minerals (like kyanite, pyroxene, amphibole, andalusite, zircon, monazite and garnet) ; while samples 4, 5 and 6 are essentially zircon-monazite sands with total impoverishment or sporadic occurrence of other minerals (like pyroxene, kyanite, amphibole and garnet). Besides samples 1 to 3 are characterised by rounded zircons, which dwindle in samples 4, 5 and 6. On the other hand zircon shows a remarkable tendency towards zoning. From the study of the Range Table, it may be seen that samples 1, 2 are mostly garnet-ilmenite sands ; while samples 2, 3 and 4 are essentially garnet poor zircon sands and samples 5 and 6 are principally monazite-zircon sands.

The nature and constitution of the heavy mineral assemblage of the sands indicate to metamorphic and acid intermediate plutonic rocks as the probable source rocks for the sediments constituting the sands.

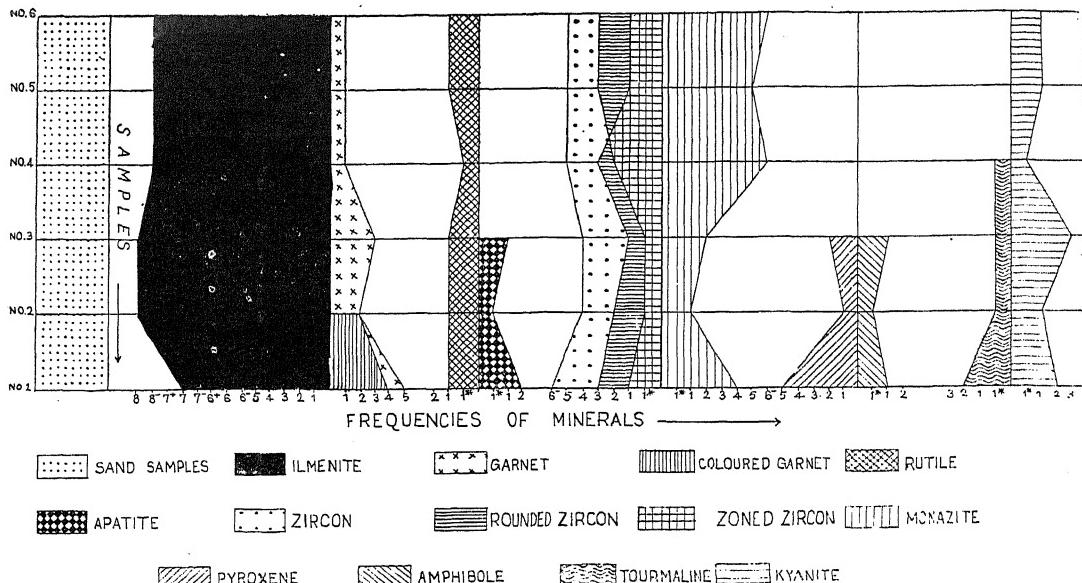
SHAPE AND SIZE STUDY

Size determinations of the heavy mineral constituents were made with the help of Micrometer ocular.⁴ The relative lengths and breadths of the various minerals were determined.

The size and shape study indicates, that the minerals are mostly angular to sub-angular, thereby indicating to inferior sorting. But, as we come to samples 5 and 6, we notice that monazite, ilmenite and zircon show a tendency to become subrounded.⁵ This feature also lends support to the conclusion arrived at above, namely, that the material has been derived from more than one source.

Further, it has received some material, which has been transported over long distance, as

RANGE TABLE I



evidenced by egg-shaped monazite, subrounded ilmenite and zircon; and some material from a source which is nearer, as evidenced by the idiomorphic outlines of zircon, zoned variety of zircon and platy form of kyanite. The latter minerals cited above vary from angular to sub-angular in shape, thereby pointing to very little evidence of transport.

The regular gradation and transition noticed in the concentration of heavy minerals from samples 1 to 6 (namely, garnet, ilmenite, zircon and monazite in the order of increasing specific gravity), point to residual gravity concentration of minerals in the sands, in the seaward direction.

The authors thank Dr. P. R. J. Naidu, for his general interest and going through the manuscript.

Department of Applied Geology, S. K. BABU.
University of Saugor, S. C. JACOB.
April 11, 1961.

ORIGIN OF VEMPALLE SHALES AND LIMESTONES IN CUDDAPAH BASIN BASED ON TRACE ELEMENT STUDY

TRACE element study of clays in shales and limestones is of recent origin.¹⁻³ In the present investigation a semi-quantitative study of the elements present has been made in the sediments of the Vempalle stage of the Cuddapah System with the objective of delineating their mode of origin. The stratigraphic succession of the Lower Cuddapahs in the area is as follows:

Cheyyeru series	Tadpatri shales
	Pulivendla quartzites
Papaghni series	Vempalle shales and limestones
	Gulcheru quartzites
Archæans	Gneisses and granites

The Vempalle stage can be roughly divided into two divisions, the lower one predominantly shale and the upper one predominantly limestone.

Five samples of shales and five of limestones were collected in the field roughly along the strike (W.N.W.-E.S.E.) of the formation within a distance of 25 miles between Velidenda and Vempalle in the Cuddapah district. The samples were washed, dried, and were treated with enough amounts of 2N HCl to remove the carbonates. After repeated washing with distilled water the samples in suspension were passed through a sieve (less than 66 microns) and were later dispersed with NH₄OH (to give pH 10) and then centrifuged to obtain the clay

1. Groves, A. W., "Heavy minerals of plutonic rocks of Channel Islands," *Geol. Mag.*, 1927, **64**.
2. Tatarsky, V. B., *Microscopic Determinations of Carbonate Minerals*, Leningrad State Sci. and Tech., Publishing House of Oil and Fuel Literature, 1955 (Original in Russian).
3. Evans, P., et al., "Graphical representation of heavy mineral analyses," *Quart. J. Geol. Min. Met. Soc. India*, 1934, **6**, 46.
4. Holmes, A., *Petrographic Methods*, Thomas Murby, London, 1921, 341.

fractions (less than 2 microns).² The samples were dried in sample tubes. These were arced using a Hilger Large Quartz Littrow Spectrograph.

A perusal of the spectrum of each sample showed that the proportion of each individual element differs slightly from one sample to another. The spectra reveal the characteristic lines of the most abundant elements like Mg, Ca, Fe, Al and Si. The next prominent group of elements identified roughly in the order of abundance are Ti and V followed by Sr, Cr, Co and Cu. Na, K, Mn, Ga, Sc, Sn and Pb are also present. From the intensity and frequency of the spectral lines of nine of the trace elements common to the shales and limestones, it is found that V, Cr, Cu, Sc, Sn and Ga tend to be comparatively more abundant in the shales and Sr, Co and Pb more abundant in the limestone samples. Similar observations of relative abundance have been made by authors elsewhere.⁴

The ionic potential of an element largely determines its place of deposition during formation of sedimentary rocks. Figure 1 shows the fields of soluble cations, hydrolysates and soluble complex anions.⁵ On this is circumscribed a field which includes the elements found in the samples. It is significant that this field does not include any element in the field of soluble complex anions. An examination of the geochemistry of the elements B, C, N, P and S shows that these are very insignificant in inorganically formed calcareous sediments and are prominent in sediments of organic origin.⁶

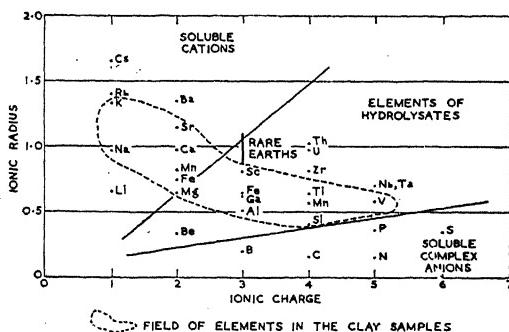


FIG. 1. Geochemical separation of some important elements on the basis of their ionic potential. (After Mason, 1958, p. 157.)

There is further evidence to show that the shales and limestones have been formed in quiet waters in a large basin essentially by chemical processes. The delicate lamination in the siltstones and shales as found in the hillocks near Virannagattupalle (Lat. $15^{\circ} 20' 5''$; Long. $78^{\circ} 29'$

15") and at the road cutting $1\frac{1}{2}$ miles north-east of Kottalu (Lat. $15^{\circ} 20' 30''$; Long. $78^{\circ} 14'$) are indicative of quiet water deposition.⁷ Limestone forms either by physico-chemical changes or by vital processes of organisms. No mega or micro-fossils have been found in the limestones in this area under study, but pisolithes and oolites are present. The general consensus of opinion regarding these is that they are of chemical origin.⁸

That there was an uplift of the rocks of the Papaghni series prior to the deposition of the Pulivendlas can be deduced from the fact that the Pulivendla quartzites at their base consist of conglomerates which contain a good proportion of chert pebbles derived from the Vempalle limestones. This uplift considerably shallowed up the basin. It was in these shallow waters that the blue-green algae, which built up stromatolites,⁹ would have thrived. These stromatolites are seen in a few places in the uppermost horizon of the Vempalle limestone. The types found here occur in the intertidal environment,¹⁰ namely in the shallow water horizon.

Hence it can be concluded that the shales and limestones of the Vempalle stage are essentially precipitates of chemical origin, the basin being shallowed towards the end of the Papaghni epoch forming favourable sites for the formation of stromatolites.

My grateful thanks are due to Prof. C. Mahadevan for his guidance and interest in this study.

Geology Department,
Andhra University,
Waltair,

R. VAIDYANADHAN.

August 12, 1961.

- Degens, E. T., Williams, E. G. and Keith, M. L., *Bull. Am. Assoc. Petro. Geol.*, 1957, **41** (11), 2427.
- , — and —, *Ibid.*, 1958, **42** (5), 981.
- Hirst, D. M. and Nicholds, G. D., *Jour. Sed. Petro.*, 1958, **28** (4), 468.
- Krauskopf, K. B., *Eco. Geol.*, 1955, **50** (Annual Vol., No. 1), 413.
- Mason, B., *Principles of Geochemistry*, John Wiley & Sons, New York, 1958, p. 156.
- Goldschmidt, V. M., *Geochemistry*, Oxford University Press, London, 1954, pp. 287, 345, 463, 529.
- Pettijohn, F. J., *Sedimentary Rocks*, Harper Bros., New York, 2nd edition, 1957, p. 593.
- Dunbar, C. O. and Rodgers, J., *Principles of Stratigraphy*, John Wiley & Sons, New York, 1957, p. 234.
- Vaidyanandhan, R., *Curr. Sci.*, 1961, **30** (6), 221.
- Logan, B. W., Rezak, R. and Ginsburg, R. N., *Abs. Geo. Soc. Am.*, 1961, **71** (12), part 2, 1918.

USE OF CHILLED WATER IN PRAWN PROCESSING WORK

A COMPARATIVE study of the effect of using chilled water and tap-water during the various stages of processing of prawn has been made. Five pound blocks of backwater and sea prawns in the headless and peeled and deveined forms were frozen using chilled water below 6° C. and tap-water at or below 25° C. at all the stages of preparation of the products. These were separately sampled at different stages, *viz.*, before washing, after washing, after packing in trays and after freezing for total bacterial plate counts. The washing time usually varied between 5 and 10 minutes, the interval between washing and packing being 30 minutes and that between packing and freezing about one hour during which the trays were kept in a chill storage. For comparison the total bacterial plate counts of frozen products prepared from the same batch using the two types of water are presented in the histogram (Fig. 1).

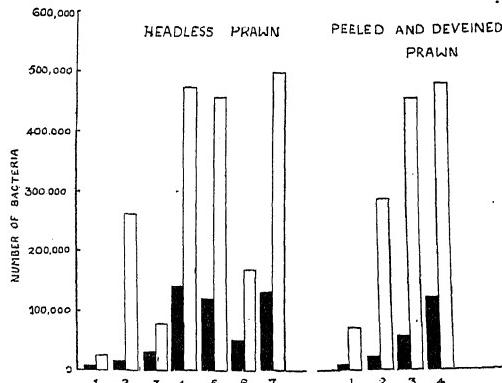


FIG. 1. Histogram showing the difference in the total bacterial plate count of the same samples of headless, and peeled and deveined prawn treated with tap-water and ice-cold water.

It has been noted that there is a uniform reduction in the bacterial counts of the material as a result of washing irrespective of the type of water used. However, samples washed in tap-water show considerable increase in the bacterial counts during the interval between washing and packing, whereas the changes in bacterial counts over the same period in samples treated with chilled water are not significant. There is also wide disparity between the bacterial counts of the two sets of samples washed and glazed with chilled water and tap-water respectively, after freezing (*vide* histogram). It can, therefore, be concluded that the use of chilled water during different stages of

processing of prawns helps in keeping down the bacterial load in the final frozen product. It has also been demonstrated to the trade that adoption of this improved processing technique presents no practical difficulties under commercial freezing conditions.

Central Fisheries Technological V. K. PILLAI.
Research Station, A. LEKSHMY.
Ernakulam-1, June 6, 1961.

THE ARCHEGONIAL COMPLEMENT OF *BOTRYCHIUM LANUGINOSUM* WALL. EX HOOK. ET GREV.*

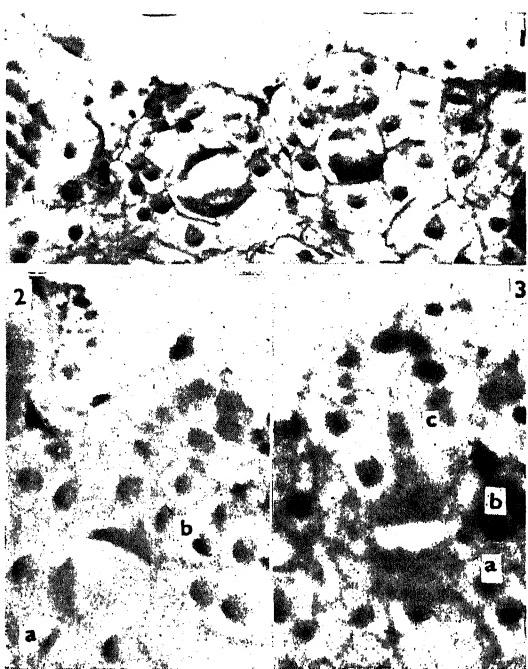
THERE appears to be some difficulty in demonstrating the presence of the ventral canal cell in the archegonial complement of Ophioglossaceæ. This is specially so in the case of *Botrychium*, as can be seen from the views expressed by the previous workers on that genus. The ventral canal cell is ascribed to be ephemeral, very inconspicuous and impossible to detect and hence its very formation itself is doubted.

Jeffrey (1898) figures a very evident ventral canal cell whose nucleus is much smaller than that of the egg or the neck canal cell. He says further, that one rarely finds this canal cell intact, as it quickly disintegrates and in preserved material, at any rate, is represented by an indistinct mass thrust against the wide base of the cervical canal. Bruchmann (1906) was unable to find a ventral canal cell in *B. lunaria* nor did he apparently see the division of the nucleus of the neck canal cell. Campbell (1911) found the ventral canal cell of *B. virginianum* as that of *Ophioglossum* very inconspicuous and often impossible to detect. He could not demonstrate satisfactorily the presence of ventral canal cell in *B. obliquum* although several preparations were secured which indicated that ventral canal cell—at least a nucleus representing this—was present. There was, however, one case where, in close contact with the nucleus of the central cell, a second smaller nucleus was visible and a zone of somewhat denser cytoplasm but no evident cell-wall. A similar difficulty has been experienced in his investigations of other Ophioglossaceæ (Campbell, 1921). It seems probable that in these cases, the ventral canal cell is cut off very soon before the opening of the archegonium and almost immediately ejected. It is not unlikely that there may be no division wall formed and that the ventral canal cell is represented by a nucleus.

Nozu (1954) mentioned a ventral canal cell in *B. japonicum* but gave no illustration to support this statement.

Nishida (1954) was able to see only in one case of *B. japonicum* a nucleus which looked like a ventral nucleus.

According to Eames (1936) the ventral canal cell is inconspicuous and apparently disintegrates early.



FIGS. 1-3. Fig. 1. Section of the gametophyte of *Botrychium lanuginosum* showing the longitudinal sections of two archegonia. The partition wall between the egg cell and the ventral canal cell is seen, $\times 210$. Fig. 2. Longitudinal section of an archegonium showing the egg cell and the ventral canal cell, $\times 350$. Fig. 3. Median longitudinal section of an archegonium showing the full complement—an egg cell, a ventral canal cell and two neck canal nuclei, $\times 350$.

In *Botrychium lanuginosum*, however, the author was able to demonstrate clearly the presence of the ventral canal nucleus, the partition wall separating the egg cell from the ventral canal cell as well as the divided neck canal nuclei. Figure 1 shows the venter portion of two adjacent archegonia of which, we can see in the left side one the partition wall between the egg cell and the ventral canal cell. The partition wall appears to be somewhat curved or depressed. The cytoplasm of the ventral canal cell with its nucleus is seen above the partition wall, slightly projecting into the canal

region. Below the partition wall, the egg cytoplasm with its nucleus is seen, the nucleus being almost at the bottom. The archegonium on the right side shows the egg cytoplasm with its nucleus and the cytoplasm of the ventral canal cell but the partition wall is not clearly visible. In Fig. 2, the egg nucleus in the middle of the cytoplasm is seen at a, while the ventral canal nucleus surrounded by the cytoplasm is seen at b above the partition wall almost continuous with it and projecting into the neck canal. In Fig. 3 an enlarged view of an archegonium in median longitudinal section is presented with its full complement. Lower down in the venter at a the big egg cell is situated with its nucleus. The clear space just below the partition wall shows that the egg cytoplasm has receded from the partition wall. At b above the partition wall is the ventral canal cell with its nucleus as big as that of the egg or slightly smaller. The neck canal is seen very clearly extending almost to the tip of the archegonial neck. Just above the ventral canal cell at c we can see two nuclei lying one above the other and touching each other. These are the two neck canal nuclei. There is no sign of a partition wall between them. So the archegonial complement of *Botrychium lanuginosum* consists of an egg cell, a ventral canal cell and two neck canal nuclei, forming the axial row.

"Jaya Nivas",
Gavipuram Extension,
Bangalore-19,

L. N. RAO.

* What was formerly described as *Botrychium virginianum* var. *lanuginosum* S. W. (Rao, L.N., 1939) has now been definitely fixed as *Botrychium lanuginosum* Wall. Ex Hook. et Grev.

1. Bruchmann, H., "Über das Prothallium und die Sporenpflanze von *B. lunaria*," *Flora*, 1906, **96**, 203.
2. Campbell, D. H., *The Eusporangiatae*, Carnegie Institute, Washington, 1911.
3. --, "Gametophyte and embryo of *B. obliquum* Muhl.," *Ann. Bot.*, 1921, **35**, 141.
4. Eames, A. J., *Morphology of Vascular Plants*, New York and London, 1936.
5. Jeffrey, E. C., "Gametophyte of *B. virginianum*," *Proc. Roy. Cand. Inst.*, 1898, 5.
6. Nishida, M., "Morphology, gametophyte, young sporophyte and systematic position of *B. japonicum*," *Phytomorphology*, 1954, **5**, 449.
7. Nozu, Y., "Gametophyte and young sporophyte of *B. japonicum* Und.," *Ibid.*, 1954, **4**, 430.
8. Rao, L. N., "A note on the gametophyte of *B. virginianum* var. *lanuginosum* S.W.," *Curr. Sci.*, 1939, **3**, 119.

**A MICROBIAL DISEASE OF OPHIUSA
CORONATA FABR.
(NOCTUIDAE: LEPIDOPTERA)**

Ophiusa coronata Fabr. is a pest of the ornamental creeper, *Quisqualis indica*. In certain years severe defoliation of plants occurs as a result of attack by this pest. During July 1960, the appearance of a microbial disease was responsible for almost complete eradication of *Ophiusa* caterpillars at the Indian Agricultural Research Institute farm. When the epizootic had passed it was a common sight to see large number of dead caterpillars fixed to the leaves of the creeper. Most of the diseased caterpillars were in the late larval instars.

The infected caterpillars cease to feed and one of the symptoms of the disease was a slight discolouration of the abdominal segments, which is normally of a dark green colour. The discolouration spreads all over, and after death it changes into a jet dark hue. In the advanced stage the body becomes flaccid and a dark brownish fluid oozes out of its mouth. The cuticle of the abdominal segments soon becomes glossy, moist and more or less transparent, showing the yellowish green inclusion bodies in the diseased cells. There is a general paralysis of the body of the caterpillar except for intermittent tremors of thoracic legs and mouth parts. Upon death which apparently takes place in about 2-3 days after the visible signs of disease appear, the cuticle except in the thoracic and head regions becomes brittle so that the least stress pulls it apart, allowing the fluid containing the inclusion bodies to flow out. Soon after the caterpillar dies, the cadaver breaks down into a decaying mass and the leaf surface gets covered with the exuded material from the caterpillar. Transmission of the virus from the diseased to a healthy caterpillar apparently occurs by way of contaminated food. Further work is in progress.

Thanks are due to Dr. B. P. Pal, Director, and Dr. E. S. Narayanan, Head of the Entomology Division, for their interest in this study.

Division of Entomology, T. V. VENKATRAMAN,
Indian Agri. Res. Inst.,
New Delhi-12, May 5, 1961.

**SOME APHIDS NEW TO INDIA, WITH
DESCRIPTION OF A NEW SUBSPECIES**

SURVEYS conducted by the author have resulted in the collection of some interesting species of Aphididae from West Bengal hitherto unknown from India. Sixteen such species and their

host plants are briefly reported here and a new subspecies is described.

Aphis ruborum (Börner)¹: Ex. *Rubus lineatus*. The dorsal hairs are longer than in the European form but further confirmatory observations are necessary. *Acyrthosiphon malvae* (Mosley)²: Ex. *Calceolaria* sp. *Acyrthosiphon citricola* (v.d.G.)³: Ex. *Citrus reticulata*, *Litsaea polyantha* and *Photinia integrifolia*. *Schoutedenia lutea* (v.d.G.)⁴: Ex. *Bœhmeria polystachya*. *Glyphinaphis bambusae* (v.d.G.)⁵: Ex. *Bambusa* sp. *Ceratoglyphina bambusae* (v.d.G.)⁶: Ex. *Bambusa* sp. The Indian material differs from the species described from Java by the possession of longer hairs on the frontal horns. It is, however, retained in the same species for the present. *Melanaphis bambusae* (Fullaway)⁷: Ex. *Bambusa* sp. *Myzocalcis kahawaluokalani* (Kirk.)⁸: Ex. *Lagerstroemia* sp. and *Lawsonia alba*. *Prociphilus* sp.: Ex. *Tsuga brunoniana*. *Smynthorodes betae* Westw.⁹: Ex. Roots of Compositæ. *Nippolachnus piri* Mats.¹⁰: Ex. *Pyrus communis*. *Eutrichosiphum vandergooti* Ray Chaudhuri¹¹: Ex. *Quercus serrata*. *Paratrichosiphum tattakanum* (Takah.)¹²: Ex. *Quercus* sp. *Formosaphis micheliae* (Takah.)¹³: Ex. *Magnolia campbellii* and *M. stellata*. *Capitophorus formosartemisiae* (Takah.)¹⁴: Ex. *Artemisia dentata*. The Indian specimens appear to have considerably longer siphunculi than those described by Takahashi but it seems desirable to retain the Indian form in the main species until Formosan material is available for comparison. *Capitophorus hippophaes* Koch, subsp. *Javanicus* H.R.L.¹⁵: Ex. *Polygonum* sp., *Cervaphis rappardi* H.R.L., subsp. *indica* nov. subsp. *Apterous viviparous* female.

Morphological characters: Differs from *Cervaphis rappardi* H.R.L.¹⁶ sensu stricto as follows: Live colour light-green. Body longer measuring about 1.47-1.69 mm. Marginal branched processi on 5th abdominal tergite always less than half of the maximum width of body; frontal processi including the apical hair always shorter than half the length of antennæ. Siphunculi appreciably shorter than the antennæ, not uniformly pale but distinctly dark near the apices. Other characters as in the main species.

Colonies of this aphid were found to infest the tender shoots and leaves of *Cajanus indicus*, without any marked injury to the host. Uptill now the new subspecies is known only from Matelli, in the district of Jalpaiguri, West Bengal.

The author is grateful to Dr. D. Hille Ris Lambers of Bennekom, Netherlands, for his valuable suggestions and to Dr. S. N. Banerjee,

TABLE I
Measurement in mm.

No.	Length body	Ant.	Siph.	III	IV	Procession		
						Front	5th abd. terg.	7th abd. terg.
1	1.55	0.43	0.35	0.208	(0.056+0.088)	0.19	0.35	0.49
2	1.61	0.45	0.38	0.208	(0.064+0.100)	0.19	0.41	0.54
3	1.58	0.47	0.40	0.216	(0.064+0.112)	0.19	0.35	0.54
4	1.58	0.45	0.33	0.192	(0.072+0.104)	0.17	0.33	0.45
5	1.62	0.47	0.37	0.224	(0.064+0.096)	0.19	0.40	0.49
6	1.47	0.40	0.33	0.176	(0.064+0.080)	0.17	0.37	0.48
7	1.69	0.48	0.40	0.216	(0.072+0.100)	0.21	0.46	0.57
8	1.60	0.46	0.37	0.208	(0.064+0.104)	0.17	0.38	0.49

1-4, On *Cajanus indicus*, Matelli, 16-XII-1958 ; 5-8, *idem*, 27-I-1959.

Entomologist, Government of West Bengal, for the facilities provided for the study.

Section of Entomology, A. N. BASU.
State Agricultural Res. Inst.,
Calcutta-40, May 22, 1961.

1. Börner, C., *Anz. Schädlingsk.*, 1932, 8, 33.
2. Mosley, O., *Gard. Chron.*, 1841, 1, 684.
3. Goot, P. van der, *Contrib. Faune Indes Néerl.* 1917, 1, fasc. 3, 34.
4. —, *Ibid.*, 154.
5. —, *Ibid.*, 232.
6. —, *Ibid.*, 235.
7. Fullaway, D. F., *Ann. Rept. Hawaii Agr. Expt. St.*, 1909, 35.
8. Kirkaldy, G. W., *Proc. Ent. Soc. Hawaii*, 1907, 1, 101.
9. Westwood, J. O., *Gard. Chron.*, 1849, 7, 420.
10. Matsumura, Sh., *Jl. Coll. Agr. Sapporo*, 1917, 7, 382.
11. Ray Chaudhuri, D. N., *Zool. Verh.*, 1956, No. 31, 19.
12. Takahashi, R., *Aph. of Formosa*, 1925, Pt. 4, 30.
13. —, *Ibid.*, 53.
14. —, *Ibid.*, 1921, Pt. 1, 25.
15. Hille Ris Lambers, D., *Temminckia*, 1953, 9, 156.
16. —, *Ent. Berichten*, 1956, Deel 16, 132.

schema operculella Zeller. The results observed are summarised below:

In the present investigation, full-grown caterpillars of *Corcyra cephalonica* previously starved for 24 hours were allowed to feed on the crushed 'Jowar' which was thoroughly mixed with 750 microcuries of P^{32} (30 caterpillars per 30 grams of 'Jowar'). After 24 hours of feeding the caterpillars were removed from the feed, washed with water several times to remove surface contamination and assayed for radioactivity. Caterpillars with radioactivity ranging from 251 c.p.m. to 500 c.p.m. were selected and exposed to the females of *B. gelechiae* for parasitisation. In the first and second generations, however, normal caterpillars were given for parasitisation. Each treatment was replicated six times and a separate control was also maintained. The experiment was conducted at an average temperature of $82^\circ \pm 10^\circ$ F. and 80% R.H.

TABLE I
Effect of beta radiations of 251-500 c.p.m.
intensity on *B. gelechiae*

	Parent generation	First generation		Second generation	
		Treatment	Control	Treatment	Control
1	Fecundity per 16 female	14	9	6	62 18
2	% viability	62.4	70.6	48.6	70.5
3	% successful completion of development	50.5	56.47	33.7	50.0
				46.5	32.4

These studies on the life-history of *B. gelechiae* indicate that the fecundity, percentage viability and percentage successful completion of development were adversely affected in the parent

EFFECT OF BETA RADIATIONS FROM P^{32} ON BRACON GELECHIAE ASHMEAD

STUDIES on the effects of beta radiations on insects have received little attention so far. Martin (1948)¹ and Blumel (1950)² made some observations on *Habrobracon juglandis* and *Drosophila* sp. respectively. Dent and Amy (1950)³ also observed some detrimental effects of these radiations on *H. juglandis*. However, Narayanan et al. (1959)* observed a stimulating effect on the eggs and first instar larvae of *Corcyra cephalonica* Stanton when irradiated for 24 hours at a dose rate of 1.1 rep./hr. (beta radiations from P^{32}). Similar studies were made on the effects of beta radiations on the eggs of *Bracon gelechiae* Ashmead, a parasite on the potato tuber moth, *Gnorimo-*

generation and more or less the same trend was maintained in the first generation (Table I). However, in the second generation, the fecundity, percentage viability and percentage successful completion of development were more than that in the control.

It was observed that the fecundity of *B. gelechiae* in the control was much less than that reported by earlier workers. This fact can be attributed to the ecological conditions under which the present studies were conducted. However, on the whole, the beneficial effects of beta radiations on this insect are evident from the data and it may be said that these radiations have a stimulating effect on the life-processes of *B. gelechiae*.

The authors are thankful to Dr. E. S. Narayanan for his keen interest in this work.

Division of Entomology, SNEHAMOY CHATTERJI.
Indian Agric. Res. Inst., G. R. SETHI.
New Delhi-12, P. N. SAXENA.
May 24, 1961. G. W. RAHALKAR.

1. Martin, A., *Genetics*, 1948, **33**, 619.
2. Blumel, J., *Science*, 1950, **111**, 205.
3. Dent, J. M., et al., *Growth*, 1950, **14**, 113.
4. Narayanan, E. S., et al., *Proc. Ind. Acad. Sci.*, 1959, **50B** (2), 82.

ESTIMATION OF CELLULASE IN THE VENTRAL CAECA OF *ORCHESTIA GAMMARELLA* PALLAS

The capability of digesting cellulose is a rare phenomenon among crustaceans. Nicholls (1931)¹ tried to investigate the presence of cellulase in *Ligia* but did not succeed.

As *Orchestia* feeds happily on paper and cloth, it was considered desirable to find out if cellulase is present in any part of the gut or accessory glands of the animal. It was detected that, although cellulase is not present in any part of the alimentary canal proper, it is present in the secretory cells of the ventral hepato-pancreatic caeca. The two pairs of very long caeca arise as ventral outgrowths of the gut at the junction of the foregut and midgut. The following experiments were performed with respect to the caecal extract of *Orchestia*.

A few drops of concentrated (10%) extract of caeca were placed on a piece of *ulva* frond; this was examined under microscope after a few weeks. It was found that the cell-walls of the frond were all intact.

A 1% Fucoid solution was then incubated with the caecal extract prepared in distilled

water. The mixture was tested after 72 hours for the presence of reducing sugars by the Benedict's solution which gave positive results. A 1% soluble Laminarin solution was similarly incubated with the extract which also gave positive results for the presence of reducing sugars, when tested after 72 hours. Finally, a 1% solution of sodium carboxy methyl cellulose when incubated with the caecal extract also indicated the presence of cellulase in the caeca. The quantity used in each incubation included 1 ml. of extract and 1 ml. of the substrate. The control experiments were also set up in all these cases, which gave negative results.

The above experiments reveal that a weak cellulase is present in the caecal cells of *Orchestia*.

Department of Zoology,
D.A.V. College,
Muzaffarnagar (U.P.) (India),
June 16, 1961.

V. P. AGRAWAL.

- I. Nicholls, A. G., *J. mar. biol. Ass. U.K.*, 1931, **17**, 675.

GROWTH REGULATORS AND ROOTING OF CUTTINGS IN *ANTIRRHINUM MAJUS* BENTH AND HOOK. (SNAPDRAGON)

Antirrhinum majus, a perennial propagated by seeds, belongs to the family scrophulariaceæ, and is known for its flowers of remarkable shades of colour.¹ Since seed propagation gives rise to variations in flower colour, attempts were made to propagate the plants by stem cuttings with the help of growth regulators. Observation on the effect of growth regulators on rooting of cuttings is reported in this note.

Matured shoots of uniform length of about 6" were selected from 3½-4 months old plants to prepare cuttings. Indole acetic acid, indole butyric acid and naphthalene acetic acid were used individually in concentrations of 4,000 p.p.m., 3,000 p.p.m., and 2,000 p.p.m. and in combinations of IAA plus IBA; IAA plus. NA A and IBA plus NAA, in concentrations of 2,000 p.p.m. and 1,000 p.p.m. The hormone powder was dissolved in alcohol and the solution was mixed with active carbon. The mixtures were dried and powdered well. The cuttings, with leaves on, were moistened in water and dipped in hormone powder and then planted in seed pans containing sand and red earth in equal proportions. There were twenty-five cuttings in each treatment. Cuttings were examined for rooting at weekly intervals and

forty days after the treatment they were lifted up for final observations. Results are summarised in Table I.

TABLE I

The effect of IBA, NAA and IAA and combinations of the three on rooting percentage, nature of rooting and average length of longest root in the cuttings of *Antirrhinum majus*

Sl. No.	Hormones in p.p.m.	Percentage of rooting	Nature of rooting	Average length of longest root in cm.
1	IAA			
	(a) 4000	12	Sparse	9.0
	(b) 3000	64	Profuse	8.2
	(c) 2000	12	Sparse	5.0
2	IBA			
	(a) 4000	32	Profuse	7.0
	(b) 3000	52	Profuse	10.5
	(c) 2000	48	Sparse	9.5
3	NAA			
	(a) 4000	40	Sparse	6.5
	(b) 3000	4	Negligible	..
	(c) 2000	24	Sparse	4.5
4	IAA plus IBA			
	(a) 2000	46	Sparse	3.6
	(b) 1000	60	Profuse	5.5
5	IAA plus NAA			
	(a) 2000	66	Profuse	7.9
	(b) 1000	26	Sparse	4.8
6	IBA plus NAA			
	(a) 2000	53	Profuse	4.3
	(b) 1000	20	Negligible	..
7	IAA plus IBA plus NAA			
	(a) 2000	66	Profuse	4.0
	(b) 1000	..	..	..
8	Control	26	..	3.0

Combinations of hormones induce better rooting than individual hormones (Fig. 1). Of the three hormones IBA ranks first in inducing roots. Lower concentrations proved to be generally unfavourable except in combination of IAA plus IBA. Rooting in cuttings was found to commence from second week after the treatment. Rooting response seems to be intimately connected with the penetration of hormones through epidermis and cortex up to the pericycle region requiring high concentration as in other woody sps.².

We are grateful to Sri. B. Venkoba Rao, Principal, for providing facilities and to Dr. H. C. Govindu, Plant Pathologist (Research and Education), for helpful suggestions. Our thanks are due to Sri. K. Shankar, Lecturer in

Chemistry, for help in preparation of hormone powders.

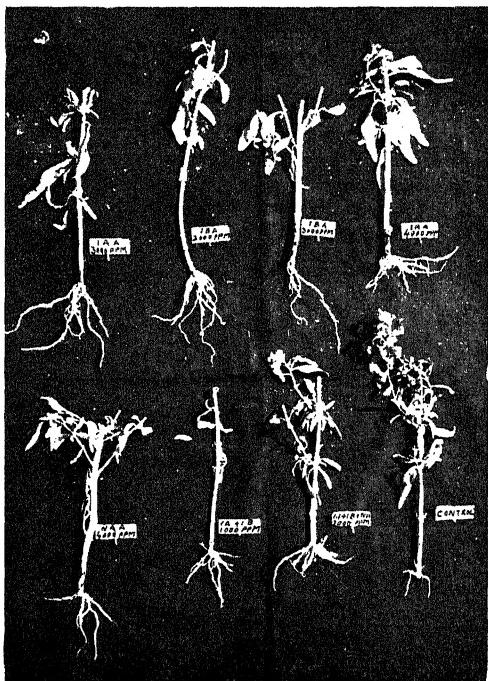


FIG. 1. Rooted cuttings (after 40 days).

D. S. LINGARAJ.

Division of Botany, S. R. CHANDRASEKHARIAH,
Agricultural College and
Research Institute,
Hebbal, Bangalore-6, June 1961.

1. Gopalaswami Iyengar, K. S., *Complete Gardening in India*, The Hosali Press, Bangalore (India), 1935.
2. Kempanna, C. and Chandrasekhariah, S. R., *Ind. Jour. of Agril. Sci.*, 1959, 29, 32.

CHROMOSOME NUMBERS IN SOME FORAGE GRASSES

This note seeks to record chromosome numbers as determined on some of the species of forage grasses under study in this Division. These counts constitute new or first records, in the sense that the number have either not been reported before or have been reported differently.

The material was grown under uniform nursery conditions as suggested by Patil (1955). The flower-buds were fixed in acetic alcohol saturated with ferric acetate and stained in propiono-carmine according to the schedule

TABLE I

S. No.	Species	Source	I.A.R.I. Acc. No.	Chromosome numbers							
				Present material				Previous reports			
				2n	n	Configurations at Metaphase I and some other features		2n	n		Authors
1	2	3	4	5	6	7	8	9	10		
1	<i>Cenchrus glaucous</i> MCR and S DD	Coimbatore	..	..	18	0-5, 0-1, 9-18, 0-4 IV III II I	..	..	..	..	..
2	<i>Cenchrus glaucous</i> MCR and S DD	do.	..	..	19	0-6, 0-2, 8-16, 0-4 IV III II I	..	..	..	..	..
3	<i>Cenchrus pennisetiformis</i> Rochst.	Rajasthan	I.W. 1537	35	..	0-6, 0-3, 3-17, 0-4 IV III II I (1-3 Univalents dividing at anaphase I)	..	..	..	..	..
4	<i>Cenchrus pennisetiformis</i> Hochst.	do.	I.W. 1537	54	..	0-1, 0-1, 0-3, 0-2 VI V IV III 20-27, 0-6 II I (1-5 Univalents dividing at anaphase I)	..	..	..	..	..
5	<i>Cenchrus setigerus</i> Vahl.	do.	I.W. 1543	37	..	0-5, 0-1, 8-18, 0-3 IV III II I (1-2 Univalents dividing)	34 36	..	..	From Darlington and Wylie, 1955	
6	<i>Iseilema fragile</i> Blacke	Australia	E.C. 14337	..	9	All bivalents; one pair conspicuously bigger sized	..	..	..	..
7	<i>Panicum coloratum</i> L.	do.	E.C. 14124	..	27	All bivalents	..	9 18 16 and 18 +1 to 3 B-Chro- mosome	..	Joshi et al., 1959 Swaminathan and Nath, 1956	
8	<i>Panicum turgidum</i> Cheval.	Rajasthan	..	..	27	Mostly bivalents; occasional univalents	..	..	..	..
9	<i>Pennisetum trisetum</i> Leeke	Kenya	..	..	18	Mostly bivalents, one pair deeply stained. Laggards bridges, fragments were seen at anaphase I; 1-3 Univalents dividing at anaphase I	..	..	..	..

described by Swaminathan *et al.* (1954) for pollen mother cells. Chromosome counts were made at diakinesis and Metaphase I.

As would be seen from Table I, the species listed 1 to 5 are polyploids in nature while Nos. 7, 8 and 9 appear to be functional diploids. *Iseilema fragile* seems to be a true diploid. It may also be noted that in the case of a single culture of *Cenchrus pennisetiformis* different chromosome numbers were discovered, indicating the existence of intraspecific chromosome races.

Division of Botany,
Indian Agric. Res.
Inst., New Delhi-12,
May 11, 1961.

B. D. PATIL.
MISS. S. K. VOHRA.
A. B. JOSHI.

- Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, George Allen and Unwin Ltd. (London), 1955.
- Joshi, A. B., Patil, B. D. and Manchanda, P. L., *Curr. Sci.*, 1959, 28, 454.
- Patil, B. D., *Indian Fmg.*, 1955, 5, 26.
- Swaminathan, M. S. and Nath, J., *Curr. Sci.*, 1956, 25, 123.
- , Magooon, M. L. and Mehra, K. L., *Indian J. Genet. Pl. Breed.*, 1954, 14, 87.

A STUDY ON THE EFFECT OF IAA AND TIBA ON VERNALISED PADDY

To study the interaction of growth regulating hormones with vernalization an investigation was undertaken with a summer variety of rice from Bengal (Charnock) using an auxin (IAA) and an anti-auxin (TIBA) in three different concentrations, 10·0 p.p.m., 0·10 p.p.m. and 0·001 p.p.m. respectively.

The seeds were first soaked in distilled water at room temperature for 10 hours and then put in the three different concentrations, kept in separate petri dishes. A control in distilled water was also maintained. For the purpose of vernalization, the dishes were kept inside a refrigerator for 4 weeks and the temperature was maintained at $12^{\circ} \pm 1^{\circ}$ C. Every alternate day the old solution was removed and fresh solution added. The seeds were subsequently germinated at room temperature for 24 hours and the sprouted seeds were sown in pots. A batch of untreated seeds soaked overnight in distilled water was also sown and this acted as general control. There were thus 8 treatments in all.

other hand, under all the concentrations a delay in flowering was recorded and this was significant under concentrations of 10·0 p.p.m. and 0·1 p.p.m.

The difference in flowering time between the two years is perhaps due to seasonal effect consequent on different time of sowing in the two years. From previous experience vernalization brings on earliness of flowering in rice only by a few days and in the present experiment this result is not apparent and with the hormone treatment there is either no change in the flowering time or it is delayed by a few days. However, these results are closely in corroboration with the work of Kojima et al. (1957) on Japanese radish where they found that the application of NAA, KIA or TIBA to seedlings at their very early stages neither had the effect to induce flower initiation of plants which were not subjected to low temperature, nor to promote the bolting of plants already vernalized.

The interaction between vernalization and growth regulating substances is not well understood. Further investigation in this connection seems necessary.

TABLE I
Flowering time in days under different treatments

	Treatments	Date of sowing 1-6-1957	Date of sowing 22-4-1958
		No. of days taken for flowering	No. of days taken for flowering
1	Control (only overnight soaking in distilled water)	96·3±0·9	108·3±0·8
2	Vernalized at $12^{\circ} \pm 1^{\circ}$ C. for 4 weeks in distilled water	99·9±1·5	109·0±1·5
3	do. in 10·0 p.p.m. IAA soln.	100·6±1·2*	112·3±1·2*
4	do. in 0·1 p.p.m. IAA soln.	95·2±0·7	107·5±0·7
5	do. in 0·001 p.p.m. IAA soln.	91·7±1·5*	104·7±0·5*
6	do. in 10·0 p.p.m. TIBA soln.	102·6±1·2*	114·0±1·4*
7	do. in 0·1 p.p.m. TIBA soln.	101·5±1·1*	115·3±1·1*
8	do. in 0·001 p.p.m. TIBA soln	98·3±1·4	109·8±0·8

* Significant at 5% level.

The flowering behaviour has shown almost the same tendency in both years (Table I). In comparison with untreated, unvernalized plants, the vernalized plants showed no significant difference in flowering. Whereas plants where both the vernalization and auxin or anti-auxin treatments were given behaved differently; when treated with 10·0 p.p.m. of IAA, the flowering was significantly delayed but under lower concentrations as 0·001 p.p.m., a slight accelerating effect was recorded. In case of TIBA, on the

I am much indebted to Prof. P. K. Sen for his valuable suggestions and encouragement. Department of Agriculture, G. N. MITRA. Calcutta University, 35, Ballygunge Circular Road, Calcutta-19, March 14, 1961.

1. Kojima, H., Yahiro, M. and Eto, T., *Journ. Faculty of Agri., Kyushu Univ.*, 1957, 2 (1), 25.

REVIEWS

Advances in Chemical Physics, Vol. III. Edited by I. Prigogine. (Interscience Publishers, New York-1, N.Y.), 1961. Pp. ix + 372. Price \$ 11.50.

We had occasion to mention the general features and the importance of this series when we reviewed the second volume in these pages (*Curr. Sci.*, 1961, 30, 157). The present volume contains the following eight articles: (1) Mechanisms of organic electrode reactions by P. J. Elving and B. Pullman; (2) Non-linear problems in thermodynamics of irreversible processes by Thor A. Bak; (3) Propagation of flames and detonations by J. O. Hirschfelder and C. F. Curtiss; (4) Large tunnelling corrections in chemical reaction rates by H. S. Johnston; (5) Aspects Recents du Diamagnetisme (in French) by A. Pacault, J. Hoarau, and A. Marchand; (6) Powder electrodes and their applications by W. Tomassi; (7) Variational principles in thermodynamics and statistical mechanics of irreversible processes by Syu One, and (8) Electron diffraction in gases and molecular structure by O. Bastiansen and P. N. Skancke.

In the article on *Organic electrode reactions* the authors have summarized current approaches to the problem of the elucidation of the mechanism of the half-cell reaction for the electrolysis of an organic compound at an electrode. Another article in this field of study is the one by Tomassi on *Powder electrodes* where this technique is described and data are given on the applications of powder electrode electrolysis in potentiometric investigations of adsorbents, contact substances and dispersed crystal organic substances.

The two articles on thermodynamics of irreversible processes are of a highly mathematical nature and take the interested readers to the latest developments in this field of study.

The article on *Diamagnetism*, which is in French, gives a comprehensive survey of the subject giving the experimental methods of measuring diamagnetic susceptibility, the theories connected with them, magnetic susceptibilities of metallic crystals, graphite (mono and polycrystalline), etc.

There is a large mass of experimental data available on the behaviour of flames and detonations. However, the mathematical difficulties involved in connecting the chemical kinetics to the fluid flow properties are many. In the

article on *Propagation of flames and detonations* the authors restrict themselves to steady state problems in which the flow is not only laminar but also one-dimensional. In this case exact solutions are possible for a unimolecular reaction, and the article explains the mathematical procedure required to treat an arbitrary system of chemical kinetics.

Renewed interest on electron diffraction methods has been stimulated by improved and more accurate experimental equipment which has enabled the method to be applied to solve structural problems of greater complexity. In the last article the authors, taking examples from the work on gases done at the Institute of Theoretical Chemistry, Norway, have explained in a lucid manner the types of problems on molecular structure one can hope to solve by this method such as precision measurements of internuclear distances, valency angles, interplanar angles, vibrational amplitudes etc.

A. S. G.

Treatise on Analytical Chemistry.—Theory and Practice. Edited by I. M. Kolthoff and P. J. Elving, Part I, Vol. 2. (The Interscience Encyclopedia, Inc., New York), 1961. Pp. xx + 811-1,308. Price \$ 16.00, Subn. \$ 14.00.

The progress and development of analytical chemistry during the first half of this century has generally been covered in well-known textbooks and a number of special monographs. However, a tremendous expansion of the subject has taken place during the last one or two decades. Many of the new molecular, atomic, sub-atomic and nuclear properties that have been discovered in recent years have already found analytical application, and the field of instrumentation also has kept pace with this rapid development. The need for a comprehensive treatise on the subject which will serve as an immediate reference book has been felt not only by researchers working in academic institutions but also by analytical chemists attached to industrial laboratories.

The *Treatise on Analytical Chemistry* edited by I. M. Kolthoff and P. J. Elving aims at presenting a "concise, critical, comprehensive, and systematic, but not exhaustive, treatment of all aspects of classical and modern analytical chemistry". The Treatise will be in three

parts: I-Analytical Chemistry and its Methods; II-Analytical Chemistry of the Elements; and III-The Analytical Chemistry of Industrial Materials.

The book under review is Vol. 2 of Part I, and contains two sections, namely, Section B, on Application of chemical principles to analytical chemistry (continued from Vol. I), and Section C, on Separation: principles and techniques.

Section B, on Reactive groups as reagents, exhaustively deals with their organic and inorganic applications, Section C, on Separation deals amongst other things with Diffusion methods, Electromigration and electrophoresis, Distillation, and Vacuum methods.

Throughout the treatment the emphasis is on the analytical significance of properties and of their measurement. As a source book of information and as a guide to the efficient use of the more exhaustive treatments on specific topics, this treatise should find a place in all analytical chemistry laboratories.

A. S. G.

Synthetic Ion-Exchangers. (Recent Developments in Theory and Application.) By G. H. Osborn. (Chapman and Hall Ltd., London), 1961. Pp. x + 346. Price 50 sh.

With the publication of a few monographs on ion-exchangers like Dr. Kitchener's appearing in the Methuen's *Monographs on Chemical Subjects* and the book, *Ion-Exchangers in Organic and Biochemistry* (Editors: Kressman and Colman) the usefulness of this book is considerably affected. Half the book contains a bibliography of papers on ion-exchange resins, classified according to applications. This feature, which is highly commendable, has added both material and scientific weight to the book. Bibliography II, theoretical, is not comprehensive and up-to-date. There are a number of typographical errors.

The text proper contains the following chapters: (i) The structure, preparation and general properties of ion-exchange resins; (ii) Performance data on commercially available resins; (iii) Analytical aspects; (iv) Reactions with materials of low solubility; (v) Ion exclusion; (vi) Ion retardation; (vii) Ion-exchange membranes; (viii) Therapeutic applications; (ix) The use of ion-exchange in the control of trade effluent; (x) The economic large-scale production of deionized water; (xi) Resins as catalysts; (xii) Pulsed or jigged-bed technique; (xiii) Newer large-scale processes utilising ion-exchange resins.

The first edition of this book contained only seven chapters. Chapters (vi) and (ix) to (xiii) are the additions made in the edition under review. Much of the topical material, particularly the contents of chapters (ii), (v), (vi) and (vii) seem to have been taken from the literature supplied by the manufacturers of ion-exchange resins. As a result the book, although packed with usefulness lacks the embellishment to be found in a British scientific monograph. The book particularly the topics on the use of ion-exchange in the control of trade effluent, the economic large-scale production of deionized water, pulsed or jigged bed technique and the newer large-scale processes utilizing ion-exchange resins should prove useful to chemists and chemical engineers working in some of our university and national laboratories.

The chapter on ion-exchange membranes could have been brought up-to-date by incorporating the theoretical work of Scatchard, Kirkwood and Staverman on Membrane Potentials and the experimental work related thereto.

N. LAKSHMINARAYANAIAH.

Extractive Metallurgy of Copper, Nickel and Cobalt. Edited by Paul Queneau. (Interscience Publishers, New York, London). Pp. xv + 647. Price \$ 22.50.

This book contains a collection of papers presented at the International Symposium held in New York in February 1960 which was sponsored by the Extractive Metallurgy Division of the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers. The coverage in this Symposium Volume deals with the modern practice in the extractive metallurgy of Copper, Nickel and Cobalt, an understanding of which is of great importance to both the maker and user of these metals.

The papers have been classified in this book in five sections with a separate and excellent annotated bibliography containing some 1,190 references.

The first section under the caption 'General' contains 6 papers and the discussions, thereon; the subjects dealt with are the advantages of fluid bed roasting, treatment of Nickel-Copper matte, solvent extraction, separation by volatilization and corrosion-resisting materials of construction.

The second section on 'Fuel fired smelting and converting' has 4 papers dealing with the present practice at the Noranda and Gaspo smelters, of Phelps Dodge in Arizona, the Chino Mines

Division of Kennecott Copper Corporation and aspects on the design and operation of Copper converters.

Next follows the section on 'Electric Furnace Smelting' dealing with four papers, on smelting of sulphide ores, production of Ferronickel from low-grade Nickel ores of Oregon, the New Caledonian practice of Ferronickel smelting and on the smelting tests of Nickeliferous serpentine.

'Atmospheric and elevated pressure leaching' forms the caption of the next section which deals with 3 papers, on the present practice of Oxide concentrate leaching and electro winning, on the Chuquicamata leaching practice, and on the Sulphuric acid pressure-leaching of Nickeliferous laterites.

The last section on 'Refining' covers 6 papers dealing with the current operating practice in electrolytic Copper refining, with the role and significance of Dialysis in modern electrolyte purification, the Chuquicamata practice of tank house operation, production of refined Nickel and on the present practice of Cobalt recovery by the electrolytic and pressure hydrometallurgy techniques.

The subject-matter in this book has been well supplemented by some 88 illustrations, 52 graphs, 88 tables, 34 flow sheets and 10 microphotographs.

The Symposium Volume, though it presents the current status of the extractive Metallurgy practice of Copper, Nickel and Cobalt only, throws a challenge to the men of metals on the dynamic and new possibilities, in the fields of Hydro-Metallurgy, Pyrometallurgy and the Vapometallurgy. And this book is a 'must' for not only to the non-ferrous process metallurgist, but also to the serious-minded researcher ever in pursuit of the metals locked up either in the muds of the earth or in the waters of the sea.

A. A. KRISHNAN.

The Physical Principles of Astronautics. By Arthur I. Berman. (John Wiley and Sons Ltd., 440, Park Avenue South, New York-16), 1961. Pp. xv + 350. Price \$ 9.25.

Astronautics has become a subject by itself and before long it will find an adequate place in the curricula of Indian Universities. The book *The Physical Principles of Astronautics* will be found to be a suitable introductory text-book on the subject for a one-year course at the under-graduate level. Besides, beginner students of astronomy also will find many fundamental problems dealt with in a lucid manner.

The book is divided into three parts. Part I, of about 70 pages, deals with the elementary principles of Astronomy, especially with refer-

ence to the earth and the moon, and the physics of the solar system. In Part II, of about 50 pages, the fundamental concepts of mechanics, such as mass, weight, potential energy and Coriolis force are discussed in an elementary manner. In Part III, on dynamics of space flight, the properties of orbit, orbital perturbations, and propulsion dynamics are described. There is an appendix which gives a glossary of astronautical terms.

An Introduction to the Laplace Transformation with Engineering Applications. By J. C. Jaeger. (Methuen's Monographs, Methuen and Co., Ltd., London), 1961. Pp. viii + 156. Price 10 sh. 6 d.

Methuen's Monographs on Physical Subjects are well-known and have become indispensable additions to the book-shelves of university student's of physical sciences and engineering. The booklet under review is the second edition, the first of which was published in 1949. The less difficult approach to solving transient problems by the Laplace Transformation method rather than by the operational calculus method of Heaviside has become popular with students of engineering and physics. In the present edition the author has added a useful chapter giving a brief sketch of the theory of functions of a complex variable and the way in which it is applied in conjunction with the inversion theorem.

Paint Technology Manuals. Part I. Non-Convertible Coatings. (Published on behalf of Oil and Colour Chemists' Association. Chapman and Hall, London), 1961. Pp. 326. Price 30 sh.

This book has been brought out as first volume of the series on paint technology manuals by the Oil and Colour Chemists' Association and it is primarily intended to meet the requirements for the examination of the City and Guilds of London Institute. The 11 Chapters of this volume are based on the contributions of experienced technologists from the industry and are devoted to coating materials that do not undergo any chemical change during their application.

A large portion of the book deals with cellulose lacquers wherein cellulose nitrate predominates. Shellac, which is one of the oldest non-convertible coating materials is only casually mentioned although even today it has an important place in wood-finishing and other similar applications. Discussion on wood finishes includes polyesters, epoxide resins, polyurethanes

and malamine-alkyd formulations for coatings, which strictly speaking do not fall within the scope of the title of this book.

The chemistry of the preparation and general characteristics of cellulose nitrate, cellulose acetate and ethyl cellulose are briefly described in Chapters 1, 7 and 8 respectively. The other ingredients of cellulose nitrate base lacquers, i.e., solvents, plasticisers and pigments are adequately dealt with in Chapters 2, 3 and 4. Various chemical derivatives of rubber that find use in coatings and allied fields are briefly discussed in Chapter 9. Preparation and properties of vinyl resins with particular reference to the choice of solvents for their use as organosols, plastisols and wash primers are covered in a rather lengthy Chapter No. 10. The last Chapter (No. 11) on spirit varnishes is rather sketchy. Practical examples at the end of each chapter should be of help to students.

Authors have attempted to bring out important theoretical and practical aspects of non-convertible coatings so that one has a fairly clear idea of the type and significance of the different materials used in the preparation and application of such formulations. The inclusion of a few illustrations and a bibliography at the end of each chapter for further reading should enhance its value. This book should be useful in the training and education of paint technologists, apprentices and students taking up the City and Guilds examinations. It should be equally helpful as a guide to those engaged in the manufacture and use of lacquers.

S. L. KAPUR.

Plant Nematodes, their Bionomics and Control.
By Dr. Jesse R. Christie. (Gainesville, Florida; Agricultural Experiment Stations, University of Florida), 1959. Pp. 256. Price \$ 3.75.

Recently the plant parasitic nematodes have been observed to cause extensive damage to our food crops, orchards and ornamentals. Information on the bionomics and control of these nematodes is widely scattered and publications on the subject are available only in a few libraries. Compiled for easy reference information, this book will be invaluable to research workers on plant nematodes, especially those located at field stations with limited library facilities.

The book is divided into fourteen chapters, the first being a general introduction to plant nematodes. In the second chapter are discussed the principles of nematode control. The remaining chapters deal with one group each of the

related nematodes. Each chapter deals with the taxonomy of the group under consideration, its life-history and habits, injury caused to the plants, hosts, distribution of the nema and control. The author has provided five useful tables in the Appendix. The first lists the plant nematodes of some common crops, the second gives the control measures, the third deals with hot water treatments for denematizing planting stock, the fourth contains the common names of plant parasitic nematodes and the fifth gives a list of scientific names of nematodes attacking plants and their synonyms.

Well illustrated and pleasingly written, the book is likely to prove helpful not only to research workers but also to students, teachers, farmers and others interested in growing plants and concerned with the problem of nematode control.

PUSHKARNATH.

A Second Course in Statistics. By Robert Loveday. (Cambridge University Press, Bentley House, 200, Euston Road, London, N.W. 1), 1961. Pp. xi + 155. Price 10 sh.

This is an admirable elementary text-book on Statistics suitable for use in the first year of the university course where the principles and applications of statistics are taught. The chapters are in logical sequence leading to a short account of Quality Control followed by a treatment of regression lines by the method of least squares and of correlation coefficients.

The large number of examples in the text and exercises at the end of the book will be particularly useful to students in gaining confidence in their reading.

Studies in Indian Medicinal Plants Used in Ayurveda—Cathartics. By G. S. Pendse and M. A. Iyengar. (The Indian Drugs Research Association, Poona-5), 1961. Pp. iv + 106.

Those interested in Ayurvedic medicines and the plants from which they are prepared will find much useful material in this 100-page publication of the Indian Drugs Research Association, Poona. The controversial question about Ayurvedic drugs is whether such drugs extracted from medicinal plants by chemical methods prove as efficacious as those administered in their natural state. The problem can be solved only if the original Ayurvedic concepts relating to drug-action and drug-composition are fully understood. The study of the medicinal plants also must be oriented in such a way as to obtain maximum information in accord with these concepts. In this context the

authors have brought to bear their wide knowledge and results of their researches into relevant original texts, in the publication of this issue of the I.D.R.A.

The two drugs and the corresponding plants taken up for detailed study in this issue are Danti (*Balsiospermum montanum* Muell Arg) and Trivrt (*Operculina turpethum*).

C.S.I.R.O. Research Review, 1959-60. (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia). Pp. 418.

The record of the activities of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) for the year 1959-60 is contained in the two publications, the *C.S.I.R.O. Twelfth Annual Report* and the *C.S.I.R.O. Research Review*. Apart from information of a general administrative nature the *Report* issued earlier contained only the highlights of the research program in popular language to meet the interest of the general public. The purpose of the *Research Review* is to present the scientific details of the research programme which primarily will be of interest to the scientific community. There are about 40 chapters, each chapter being devoted broadly to one Division or Section of C.S.I.R.O.

Agricultural Sciences take priority in this Review, followed by the various sections of Chemistry, Physics, Meteorology and Industrial Research. The Division of Chemical Physics reports studies done during the year in Crystallography, Solid State Physics and Spectroscopy. One of the main responsibilities of the Division of Physics is the maintenance of the International Temperature Scale (I.T.S.). Recent developments relating to the maintenance of the I.T.S. include those in Resistance thermometry, Thermocouple and Optical pyrometry, Temperature scale in the range 0-4°K., and Cryogenics. The other activities of the Division of Physics include Hygrometry, Photometry and Colorimetry, and Solar physics.

The *C.S.I.R.O. Research Review* is a publication of current scientific value in various fields and should be in the possession of all organisations of research and scientific administration.

Grasses of Burma, Ceylon, India and Pakistan. (Excluding Bambuseæ). By N. L. Bor. (Pergamon Press, London), 1960. Pp. xviii + 767. Figs. 80. Price £ 8-0-0.

The identification and description of grasses has always posed a difficult problem to botanists, foresters and agriculturists. The account of

grasses contained in the Seventh Volume of Hooker's *Flora of British India* was published as early as 1896 and stood in urgent need of revision for a long time. Bor's book published by Pergamon Press fulfils this long-felt need and provides an admirable answer to this colossal task.

The book is divided into two parts—the General and the Systematic.

The general part is rather brief and consists of four chapters. Chapter I gives the morphology of all the parts of the grass plant, vegetative as well as reproductive, with remarks on their significance in grass systematics. These have been illustrated with examples. These notes based as they are on the vast experience of the author and his close familiarity with the taxonomy of this family will be of great value to students of agrostology who must learn to appreciate the relative value of different morphological characters. Chapter 2 deals with the various modes of dispersal of grasses. Chapters 3 and 4 which deal with the economic aspect of the grasses draw the attention of the reader to their multifarious uses, as also to some of their harmful effects. The grasses which are used as cereals, fodder, essential oils, and those which are used in medicine and conservation of soil moisture have been briefly described. Among the harmful relations are mentioned the poisonous grasses, weeds and those which cause mechanical injury to the cattle.

The systematic part forms the bulk of the book. The introductory chapter deals with Taxonomy and Phylogeny, and reviews the development of taxonomy from 1812. The bases of classification during the early period are discussed. Recent trends in taxonomy, based on the study of cytology, leaf anatomy, embryo, root hairs, shoot apex, etc., are also briefly dealt with. Bor writes "Until we accumulate a great deal more data the New Systematics poses as many problems as it solves". This view will receive applause from all orthodox taxonomists.

The systematic list of grasses covers about 700 pages. The term 'list' is appropriately used as detailed descriptions of genera and species are not given and only references have been cited for this purpose. This is justified considering the large number of species which had to be packed into a volume of convenient size and nothing better could be expected, yet full descriptions of genera and species will be missed by most people using this book. Due to frequent amputation of small new genera from large old ones the circumscription and satisfactory descriptions of the latter is a difficult task, and

the agrostologist looks to future for a 'Genera Graminearum'.

Carefully tested dichotomous keys are provided for groups, tribes, genera, species and even varieties. The alphabetical arrangement of tribes within groups, genera within tribes and species within genera may be found convenient for reference, but with a good index already appended to the book this arrangement could have been replaced by placing related genera near each other. The treatment of closely similar genera like *Bothriochloa* and *Dichanthium*, *Isielema* and *Themeda* far apart in the book may not be very convenient to users. The object of verbatim repetition of *Erianthus* species under *Saccharum* is not quite clear.

The significant feature of the book is the exhaustive synonymy for all species. Brief notes are given on their general world distribution, distribution in India, and their uses. A few representative collections have also been cited at the end of descriptions. Chromosome numbers wherever known have also been given. The book incorporates practically all the relevant findings on the grasses of this region up-to-date. A number of new species, new genera and new names have been incorporated as appendix or addenda even during the course of publication. It has an exhaustive bibliography of about 600 entries which will be of great help to future workers on this difficult group.

The printing, line drawings, and get-up of the book are of high order.

The full value of such an important work can only be revealed by long study and use. No research institution dealing with forestry, agriculture or botany can afford to be without this book which will remain a valuable work of reference for many years to come.

M. B. RAIZADA.

Books Received

Optical Microscope Technique. By D. Birchon. (George Newnes Ltd., Tower House, Southampton Street, London, W.C. 2), 1961. Pp. x + 274. Price 60 sh.

Physical Chemistry (2nd Revised Edition). By E. A. Moelwyn Hughes. (Pergamon Press, 4 and 5 Fitzroy Square, London, W. 1), 1961. Pp. vii + 1,333. Price 84 sh.

Relativistic Electron Theory. By M. E. Rose, (John Wiley & Sons, N.Y.), 1961. Pp. xii + 302. Price \$ 9.50.

Symposia of the Society for Experimental Biology, No. XV—*Mechanisms in Biological Competition*. (Cambridge University Press, London, N.W. 1), 1961. Pp. vi + 365. Price 50 sh.

From: Interscience Publishers, 250, Fifth Avenue, New York-1, N.Y.:

Fatty Acids, their Chemistry, Properties, Production and Uses. Part 2. Edited by K. S. Markley, 1961. Pp. ix + 715-1,485. Price \$ 27.00.

The Chemistry and Mode of Action of Herbicides. By A. S. Crafts, 1961. Pp. viii + 269. Price \$ 9.00.

Metallurgical Society Conferences. (Vol. 9). *Response of Metals to High Velocity Deformation*. Edited by P. G. Shewmon and V. F. Zackay, 1961. Pp. xii + 491. Price \$ 8.00.

The Abundance of the Elements. By L. H. Aller, 1961. Pp. xi + 283. Price \$ 10.00.

Advances in Enzymology (Vol. 23). Edited by F. F. Nord, 1961. Pp. v + 557. Price \$ 15.50.

Thermoelectricity Science and Engineering. By R. R. Heikes and R. W. Ure, Jr., 1961. Pp. xi + 576. Price \$ 18.50.

Reactor Hand-Book (2nd Edition, Revised and Enlarged), Vol. II—*Fuel Reprocessing*. Edited by S. M. Stoller and R. B. Richards, 1961. Pp. xii + 665. Price \$ 21.40.

Diazo and Azo Chemistry—Aliphatic and Aromatic Compounds. By H. Zollinger, Translated by H. E. Nursten, 1961. Pp. 444. Price \$ 16.50.

Euglena—An Experimental Organism for Bio-Chemical and Biophysical Studies. By Jerome J. Wolken (Institute of Microbiology, Rutgers, The State University, New Brunswick, New Jersey), 1961. Pp. xii + 173. Price \$ 4.50.

College Botany (Vol. I, 2nd Edition). By H. C. Gangulee, K. S. Das and C. Datta. (The Central Book Agency, 14, Bankim Chatterjee Street, Calcutta-12), 1961. Pp. xxv + 1,087.

Anthropology in India. By L. A. Krishna Iyer and L. K. Bala Ratnam. (Bharatiya Vidya Bhavan, Bombay-7), 1961. Pp. xv + 257. Price Rs. 10.

Science and the Future of Mankind. Edited by Boyko. (Dr. W. Junk, Publishers, The Hague, Netherlands, 13, Vanstolkweg), 1961. Pp. vii + 380. Price \$ 9.50.

SCIENCE NOTES AND NEWS

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Zoology to Shri M. V. Narasimha Rao for his thesis entitled "Cytogenetic Studies in Some Ciliates (Protozoa)".

Utkal University has awarded the Ph.D. Degree in Chemistry to Shri R. K. Pattanayak for his thesis entitled "Studies on Some Citrate Complexes"; and Ph.D. Degree in Botany to Shri Gopinath Sahu for his thesis entitled "Certain aspects of the Physiology of Growth and Reproduction in Rice".

Osmania University has awarded the Ph.D. Degree in Botany to Shri P. Ramachar for his thesis entitled "A Monographic Study of the Uredinales Parasitizing the Grasses of the Tribe Paniceæ".

Symposia on "Vacuum Science" and "Nuclear Physics"

The Institute of Physics and the Physical Society announces the following two symposia to be held at Imperial College of Science and Technology, London. (i) A one-day symposium on "Some aspects of vacuum science and technology", on 5th January, 1962. The scope of the symposium will be: (a) continuously exhausted bakeable vacuum apparatus for pressures below 10^{-9} mm. of mercury and (b) the controlled deposition of evaporated film.

(ii) A two-day symposium on "High energy nuclear physics", on 26-27 March, 1962. Several review lectures on both theoretical and experimental topics in high-energy nuclear physics will be included in the programme. A limited time will be devoted to short communications.

Further details and application forms may be obtained from the Administration Assistant, The Institute of Physics and the Physical Society, 47, Belgrave Square, London, S.W. 1.

Symposium on "Ferro-Alloy Industry in India"

The National Metallurgical Laboratory, Jamshedpur (India), is organizing a Symposium on "Ferro-Alloy Industry in India" to be held early in February, 1962. The scope of the Symposium will broadly cover the following with respect to ferro-alloys: Survey of raw materials; Beneficiation of raw materials for indigenous ferro-alloy industry; Evaluation of production techniques and principles; Latest advances in

production technology; Utilisation of by-products; Standard specifications; and Present status of ferro-alloy industry in India and future expansion plans.

Invitations are being extended to technologists, metallurgists and research scientists in India and abroad to attend the Symposium in person and contribute technical papers for discussion. Further particulars can be had from Dr. T. Banerjee, Deputy Director, National Metallurgical Laboratory, Jamshedpur-7.

Birbal Sahni Institute of Palaeobotany, Lucknow

The Fourteenth Annual Scientific Meeting of the Palaeobotanical Society will be held at the Institute premises on the 21st and 22nd January 1962. Palaeobotanists from all over India are expected to participate, and the programme will include lectures, presentation and discussion of papers, etc.

Managing Director of Messrs. James A. Jobling and Co. Ltd., Visits India

Messrs. Gordhandas Desai Private Limited Pherozeshah Mehta Road, Bombay-1, Sole Agents in India for PYREX Laboratory and Scientific Glassware, inform us that Mr. J. A. Cochrane the Deputy Chairman and Managing Director of Messrs. James A. Jobling and Co. Ltd. Sunderland, England, manufacturers of Laboratory Pyrex Glassware, will be visiting India from October 20-28, 1961. Mr. Cochrane accompanied by Mrs. Cochrane, is on a six-week world goodwill tour visiting their overseas agents and distributors. Their itinerary in India will include Bombay, Delhi, Agra and Calcutta.

International Rubber Conference

The 'Institut Francais Du Caoutchouc' is organizing, under the ægis of the International Rubber Research and Development Board, an International Rubber Conference to be held in Paris from May 14th to 18th, 1962.

This meeting has two objects in view: (1) to review the latest progress of natural rubber in the field of scientific knowledge, productivity and improvement of qualities; and (2) to compare respective values between natural rubber and synthetic rubbers and thus bring out the prospects in this field.

The I.F.C. has established a programme of "communications" which will be given for the natural rubber by the members of the various Institutes of the I.R.R.D.B. and for the synthetic rubbers by research and technical experts in these products. In addition, plenary Conferences have been arranged during which prominent French and foreign personalities of the rubber world will do the synthesis of the present knowledge. For all informations apply to the Secretariat of the Conference, C/o. Mr. G. Daugy, 42, rue Scheffer, Paris (16).

A Tetramerous Flower of *Abutilon indicum* Sweet.

Messrs. A. R. Chavan, S. D. Sabnis and S. J. Bedi, Department of Botany, M.S. University of Baroda, Gujarat State, write :

Plants of the family *Malvaceae* usually exhibit a pentamerous arrangement of the Calyx and corolla whorls. During one of our recent botanical excursions, we were able to collect a flower of *Abutilon indicum*, which showed a tetramerous arrangement. In this flower, the carpels and the monadelphous stamens are normal. The sepals are four and united almost up to the top. The petals are yellow, united up to the middle, three of them being notched at the apex. One of these notched petals is bigger than the rest and approximately double the size of the smallest one.

As far as the authors are aware, no record of a tetramerous and gamopetalous flower in a malvaceous plant is available. In spite of the very meagre material and literature at our disposal, a new record of a tetramerous flower in *Abutilon indicum* is ventured.

Generation of Optical Harmonics

The development of pulsed ruby optical masers has made possible the production of monochromatic (6943 Å) light beams which, when focused, exhibit electric fields of the order of 10^5 volts/cm. The possibility of exploiting this extraordinary intensity for the production of optical harmonics from suitable nonlinear materials is most appealing. In a letter (*Phys. Rev. Letters*, August 15, 1961). Franken *et al.* discuss the requisite analysis and describe experiments in which they have observed the second harmonic (at ~ 3472 Å) produced upon projection of an intense beam of 6943-Å light through crystalline quartz.

A suitable material for the production of optical harmonics must have a nonlinear dielectric coefficient and be transparent to both the

fundamental optical frequency and the desired overtones.

Since all dielectrics are nonlinear in high enough fields, this suggests the feasibility of utilizing materials such as quartz and glass.

In the experiments they have used a commercially available ruby optical maser which produces 3 joules of 6943 Å light in a one millisecond pulse. This light is passed through a red filter for the elimination of the xenon flash background and is then brought to a focus inside a crystalline quartz sample. The emergent beam is analysed by a quartz prism spectrometer equipped with red insensitive Eastman type 103 spectrographic plates. The plate showed an unambiguous indication of second harmonic (3472 Å).

Theoretical prediction as developed in the paper is confirmed by the following two facts : (1) The light at 3472 Å disappears when the quartz is removed or is replaced by glass, (2) The light at 3472 Å exhibits the expected dependence on polarization and orientation.

New Moons

Polish astronomer K. Kordylewski of the Cracow Observatory has reported the discovery of two cloud-like objects that appear to be natural satellites of the earth. They lie in the same orbit as the moon and just at a point where an 18th century mathematical analysis predicted they might be found.

In 1772 the French mathematician and astronomer Joseph Louis Lagrange calculated that there are five points of gravitational equilibrium around a pair of massive bodies. These are since known as Lagrange points and designated by the letter L. Three of these correspond to crests of a hill and represent an unstable equilibrium. Two, L_4 and L_5 , are gravitational pits; a small body in either position tends to stay there. In the case where one of the massive bodies revolves around the other, L_4 and L_5 lie on the orbit, respectively 60° ahead of and behind the revolving body.

In 1904 a small mass was found oscillating around the L_4 point of the Sun-Jupiter system. It was one of the Trojan asteroids of which 11 others have since been identified, some at L_4 and others at the L_5 point behind Jupiter.

Kordylewski looked for similar objects in the earth-moon system. After several years of searching he photographed, last March and April, two faint clouds circling the earth at the L_4 point behind the moon. This discovery was announced at the International Astronomical

Union. The satellites appear to be collections of meteoritic material. Kordylewski suggests that similar satellites may be found at the L₄ point ahead of the moon, which will next be in position for observation from the earth beginning in September.—(*Scientific American*, August 1961.)

Spark Chamber

A new detector called the spark chamber of which currently experiments are going on promises to be a worthy competitor to the bubble chamber. It consists of a set of parallel conducting plates, set about half an inch apart in a vessel containing gas such as neon. Alternate plates are connected to opposite sides of a generator, producing a potential of about 10,000 volts between each pair. When a charged particle passes through the array, it leaves a segmented trail of ionized gas atoms between the plates. Each segment acts as a nucleus for a localized spark that jumps from one plate to the next. By photographing the tracks of sparks from two perpendicular directions, the three-dimensional path followed by the particle can be reconstructed.

This arrangement has several advantages. It is simple. It operates at atmospheric pressure. Neither the gas nor the plate material need be highly purified, and the exact shape of the plates is not critical.

The spark trail is not so fine as those in cloud or bubble chambers; hence its space resolution is poorer. But the time resolution is thousands of times better. The high voltages on the plates can be applied in pulses lasting only a ten-millionth of a second. Between pulses a small, steady voltage sweeps the gas clear of ions. Therefore only the particles passing through the chamber during the time of the pulse leave visible tracks.

The first working spark chamber was built in 1959 by S. Fukui and S. Miyamoto in Japan. Currently a 10-ton spark chamber made of 100 aluminium plates each 4 ft. square and 1 inch thick, is being assembled in the Colombia University. The device will be used in conjunction with the 30 BeV synchrotron at the Brookhaven National Laboratory in experiments on high-energy neutrinos.—(*Scientific American*, July 1961.)

On Possible Parent Substances for the C₂ Molecules Observed in the Alphonsus Crater

Apropos Kozyrev's observation of the fluorescent Swan bands emitted by gases escaping from the Alphonsus crater of the moon, it is of interest to inquire as to what compounds might be coming from the lunar interior which would supply the C₂ molecules responsible for the Swan bands. H. C. Urey in a note in *Astrophysical Journal*, 1961, Vol. 134, p. 268, examines the various possibilities.

Volatilization of graphite would require very high temperatures, and no satisfactory evidence for such temperatures has been presented. Since molecular collisions can hardly occur after the gas becomes exposed to sunlight because of the low pressures, C₂ can hardly be formed during collisions between molecules containing only one atom of carbon. Hence methane or other molecules containing a single atom of carbon cannot be the parent molecules.

The next molecule to consider would be acetylene, C₂H₂. But this is a very unstable molecule relative to dissociation into its elements and can hardly have been stored as such for a long period of time. It is made in terrestrial laboratories by the action of water on calcium carbide, CaC₂. Calcium carbide or other alkali or alkaline earth carbides could be expected to be retained in the absence of water for long times, and if water now comes from the lunar interior and makes contact with such carbide, acetylene would appear at the lunar surface. Ferrosilicon and silicon carbide are found in meteorites, and the conditions for the production of these compounds from silicon dioxide and of calcium carbide from calcium oxide are similar. Thus if material now near the surface of the Alphonsus crater have been subjected to processes similar to those required for certain of the meteorites, acetylene may be the parent molecule of the C₂ molecule.

Urey also examines the possibilities of C₂H₄, C₂H₆ and higher hydrocarbons being the parent substance for the production of C₂ and comes to the conclusion that although it is not possible to state what the parent substance or substances of the C₂ molecules observed by Kozyrev are, it would be interesting to make tests for calcium carbide in Lunar surface materials by early landings of the instruments on the moon.

712-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

CHEMISTRY AND THE SPECTROSCOPE*

R. G. W. NORRISH, F.R.S.

Department of Physical Chemistry, University of Cambridge, England

THE fundamental and detailed work conducted in laboratories must, by its nature, remain sometimes obscure to non-scientists and in some cases even to those who specialise in other branches. Yet it is indirectly of importance to everybody.

For example, flash photolysis and "kinetic spectroscopy", discovered and developed in the Laboratory of Physical Chemistry at the University of Cambridge, England, is a new and powerful method of studying the intimate nature of photo-chemical and thermal reactions over periods measured in millionths of a second. Its applications are immensely varied.

It provides means of examining the nature of explosive processes; can be applied to the study of anti-knock additives in the internal combustion engine; it yields important information about the elementary reactions in the upper atmosphere of vital value to the meteorologists and geochemists and the processes which are now believed to have created the environment on which life, as we know it, depends.

The new method yields objective information about the free radicals and other transient intermediates taking part in photo-chemical and thermal reactions. These intermediates generally have very short lives, measured in millionths of a second; nevertheless it has been possible to photograph their characteristic spectra at successive intervals of time and so to measure the rates of their growth and decay during chemical reaction. Sometimes they are produced in a highly energised state of thermal vibration, yet "cold" as regards their translational and rotational motions, and the study of this has thrown light on the propagation of chain reactions, and the transfer of energy from vibrational to other thermal degrees of freedom.

A PARAMOUNT CHALLENGE

The "kinetic spectroscopy" method involves the use of the photo-chemical technique of flash photolysis. It was discovered and developed spectroscopically in our Laboratory of Physical Chemistry at Cambridge, as I shall presently describe.

The principles of photo-chemical reaction were first conceived some 50 years ago through the

work of Warburg, Bodenstein, Henri and Weigert and took final shape through the work of others who followed. Into the whole framework have been fitted innumerable photo-chemical and thermal reactions whose postulated mechanisms, involving atoms-free radicals or excited species, are entirely derived from the circumstantial evidence afforded by spectroscopic observations and quantitative measurements involving photo-chemical kinetics, and end products. In general, the consistency of the mechanisms within the framework is so good as to lead to confidence in our conclusions, though the absence of any objective proof of the existence of the postulated intermediates has constituted a permanent challenge to the photo-chemist, and sometimes gave rise to criticism from unbelievers which weakened his position.

It was for this reason that in 1946 we decided to break new ground by endeavouring to obtain direct spectroscopic evidence for the free radicals postulated as intermediates in photo-chemical reactions. This was made possible by the discovery by Porter and myself that very large measures of photolysis could be achieved by the application of a powerful light flash to suitable reactants, such as nitrogen peroxide, iodine, or acetone, contained in a quartz vessel. These early flashes produced by discharging a bank of condensers through argon were of 1-2 milliseconds duration and dissipated up to 10,000 Joules of energy, and it seemed obvious that if free radicals were produced in the reactions, they must momentarily have been at such very high concentrations as to invite efforts to photograph their absorption spectra.

FIRST ACHIEVED IN 1949

This was achieved in the first instance by Porter in 1949, who, using a second flash as a photographic source triggered mechanically at short intervals after the first by the method of Oldenburg, was able to demonstrate the dissociation of chlorine and to obtain the spectrum of the CS radical by the photolysis of carbon disulphide. This early success was followed by the development of the technique; shorter photolysis flashes of 100 microseconds duration and of 1,000-3,000 Joules were devised, and shorter intervals between the photolysis flash and spectroscopic flash were achieved by using electronic delay circuits capable of precision timing to a few microseconds.

* Based on his Presidential Address to the Chemistry Section of the British Association for the Advancement of Science's Annual Meeting at Norwich, August and September, 1961.

It soon became apparent that the early results of flash photolysis in the gaseous systems which I have previously exemplified were vitiated by a great rise of temperature, which resulted in thermal as well as photo-chemical dissociation. This arises from the fact that when the intense flash is applied to a suitably absorbing system such as chlorine, or nitrogen peroxide, the absorbed light energy is rapidly degraded to heat: it may be calculated that a reactant at a pressure of 1 mm. absorbing one-thousandth of the emitted energy will instantaneously reach a temperature measured in some thousands of degrees. Only if a relatively large excess of inert gas (say 500 mm. pressure) is present to act as coolant, or the process is carried out in solution, can this temperature rise be kept in check, and so limited to a few—say ten degrees in the case of a gaseous system. Thus under the adiabatic conditions resulting from lack of temperature control thermal cracking or explosion as well as photolysis may be induced in suitable systems and the method of kinetic spectroscopy provides a valuable means for the observation of the rapid elementary reactions of free radicals or atoms occurring in explosive media initiated photo-chemically.

COMPREHENSIVE METHOD

We therefore have a comprehensive method which can be applied to "instantaneous" reactions in the gas phase both under adiabatic and isothermal conditions, and also to reactions in solution.

Applications are legion. The very short ultra-violet rays of the sun which do not penetrate our atmosphere bring about reactions in the

SUCCESSFUL OPERATION OF NIMROD INJECTOR

ON August 1 the first proton beam accelerated to the design energy of 15 MeV. was obtained from the linear-accelerator injector which forms the first stage of *Nimrod*, the 7,000 MeV. proton synchrotron under construction at the Rutherford High-Energy Laboratory of the National Institute for Research in Nuclear Science, Harwell. The linear accelerator consists of a cylindrical copper cavity approximately 44 ft. long and 5·5 ft. in diameter, with 48 drift tubes spaced along its axis, the whole being enclosed in a vacuum envelope. Approximately 1 MW. of radio-frequency power is supplied to the cavity at its resonant frequency of 115 Mc./s. to set up the required accelerating fields across the gaps between drift tubes. The function of the drift tubes is to screen the protons from the field when its direction reverses every alternate half-cycle, and they also contain focusing magnets

upper atmosphere, giving rise to the protective ozone layer and involving atoms and free radicals of the utmost importance to the geochemist and meteorologist; much information can be obtained about these in the laboratory by the methods I have described.

It is now believed that the primitive atmosphere of the earth was reducing, composed mainly of hydrogen, together with methane, hydrogen sulphide, water, carbon monoxide and ammonia, similar to the atmospheres of the major planets as we see them today. If the solar system had a uniform origin there must have been influences which changed our atmosphere and that of Mars from reducing to oxidising. The first is the progressive loss of hydrogen from our relatively weak gravitational field. The second is the photolysis of water and the other compounds, leading to the formation of formaldehyde and oxides of sulphur, phosphorus and nitrogen, which on interaction, according to the fascinating views of Urey and Oparin, deposited the primordial organic scum on the earth and provided the necessary medium for the evolution of life.

Many of the reactions involved can be studied by flash photolysis. Others such as the photolysis of water, methane and other hydrocarbons lie at present outside its scope, and provide a challenge to extend this powerful method to shorter wavelengths of the ultra-violet which at present escape us.

Note: Full references to the work cited are to be found attached to the report of the full address published by the British Association.

which constrain the protons to form a proper beam close to the machine axis. The drift tubes increase in length along the tank to correspond with the increase in proton velocity. Protons enter the linear accelerator with an initial energy of 0·6 MeV. from a pre-injection stage which is basically a conventional d.c. accelerator. Pulsed 15 MeV. beams will be delivered by the injector to the synchrotron at rates up to 2 per sec. and at pulse lengths up to 2 m. sec. Within the synchrotron, they will be constrained to a circular path by a suitably varying magnetic field. In this way they will make many revolutions, receiving a small acceleration at a particular point in the orbit until the output energy of 7,000 MeV. is reached. Construction work on *Nimrod* started in August 1957 and is expected to be completed during 1962.—(Nature, p. 1,043, Vol. 191, September 9, 1961.)

ON SOME METHODS OF CONSTRUCTION OF ASYMMETRICAL FACTORIAL DESIGNS

K. KISHEN

Chief Statistician to Government, U.P. Department of Agriculture, Lucknow

AND

B. N. TYAGI

Statistician, Department of Agriculture, Lucknow

1. INTRODUCTION

KISHEN AND SRIVASTAVA^{1,2} have given general methods of construction of asymmetrical factorial designs and Kishen³ has discussed the method of constructing optimum designs of the class $q \times 2^2$. Some further optimum designs of the class $q \times 2^2$ and various methods of constructing different types of asymmetrical factorial designs which have since been developed are briefly discussed in this article.

2. FURTHER OPTIMUM DESIGNS OF THE CLASS $q \times 2^2$

It has been demonstrated by Rao⁴ that for $q = 13$, a BIB design with $v = 13$, $b = 26$, $k = 6$, $r = 12$, $\lambda = 5$ exists. This design, as in the case of the BIB designs associated with the 5×2^2 and 9×2^2 designs, can be split up into two PBIB designs with parameters $v = 13$, $b = 13$, $k = 6$, $r = 6$. Consequently, writing X_0 in the pattern of one of the PBIB designs in 13 blocks and filling the remaining 7 places in each block with X_1 , and then writing X_1 in the pattern of the other PBIB design in 13 blocks and filling the remaining places with X_0 , we obtain an optimum balanced design for 13×2^2 in 26 blocks of 26 plots each. This method was indicated by M. N. Das also, in a paper presented at the Fourteenth Annual Meeting of the Indian Society of Agricultural Statistics. As in the case of the 5×2^2 and 9×2^2 designs in 10 blocks and 18 blocks respectively, this design is non-resolvable.

It has been shown by Rao that for $q = 23$, 27 and 31, BIB designs with $b = 23$, 27 and 31, and $k = 11$, 13 and 15 exist. Consequently, for the cases 23×2^2 , 27×2^2 and 31×2^2 , optimum designs in 46, 54 and 62 blocks of 46, 54 and 62 plots each respectively have been obtained. Rao has also given solutions for BIB designs with parameters $v = 12$, $b = 22$, $k = 6$, $r = 11$, $\lambda = 5$, and $v = 16$, $b = 30$, $k = 8$, $r = 15$, $\lambda = 7$; by use of which optimum designs in the cases 12×2^2 and 16×2^2 in 22 and 30 blocks of 24 and 32 plots each respectively have been constructed.

3. USE OF PSEUDO-FACTORS

Designs of the type $l \times s^2$, where $l = s^m$, m being any prime positive integer, in blocks of ls plots each can be constructed by taking the first factor as equivalent to all combinations of m pseudo-factors, each at s levels. By this procedure, optimum balanced designs can be constructed in a minimum of $(l-1)$ replications, or $(l-1)s$ blocks of ls plots each, each replication being comprised of s blocks. Balancing is achieved on $(l-1)(s-1)$ degrees of freedom for the interaction ABC. Thus, the 8×2^2 design in 7 replications, or 14 blocks of 16 plots each, is given by the 14 equations

$$\begin{array}{ll} x_1 + x_2 + x_3 + x_4 + x_5 & 0, 1 \\ x_1 + x_2 + x_4 + x_5 & 0, 1 \\ x_1 + x_3 + x_4 + x_5 & 0, 1 \\ x_2 + x_3 + x_4 + x_5 & 0, 1 \\ x_1 + x_4 + x_6 & 0, 1 \\ x_2 + x_4 + x_6 & 0, 1 \\ x_3 + x_4 + x_6 & 0, 1 \end{array}, \quad (1)$$

where x_1 , x_2 and x_3 correspond to the three pseudo-factors taken as equivalent to the first factor A, and x_4 and x_5 correspond to the second and third factors B and C. Taking X_0 and X_1 to denote, as before, the treatment combinations b_0c_0 , b_1c_1 and b_0c_1 , b_1c_0 respectively, the design would be as under:

TABLE I
 8×2^2 Design in 16-plot blocks

A	I	II	III	IV	V	VI	VII
a_0	$X_0 X_1 X_0 X_1 X_0 X_1 X_0 X_1 X_0 X_1 X_0 X_1 X_0 X_1$						
a_1	$X_1 X_0 X_0 X_1 X_1 X_0 X_1 X_0 X_0 X_1 X_1 X_0 X_1 X_0$						
a_2	$X_1 X_0 X_1 X_0 X_0 X_1 X_1 X_0 X_0 X_1 X_1 X_0 X_0 X_1$						
a_3	$X_0 X_1 X_1 X_0 X_0 X_1 X_0 X_1 X_0 X_1 X_1 X_0 X_0 X_1$						
a_4	$X_1 X_0 X_1 X_0 X_1 X_0 X_0 X_1 X_1 X_0 X_0 X_1 X_0 X_1$						
a_5	$X_0 X_1 X_1 X_0 X_0 X_1 X_1 X_0 X_1 X_0 X_0 X_1 X_1 X_0$						
a_6	$X_0 X_1 X_0 X_1 X_1 X_0 X_1 X_0 X_1 X_0 X_1 X_0 X_0 X_1$						
a_7	$X_1 X_0 X_0 X_1 X_0 X_1 X_0 X_1 X_1 X_0 X_1 X_0 X_1 X_0$						

Similarly, the 9×3^2 design in 24 blocks of 27 plots each can be readily constructed, to which reference has been made subsequently.

4. OPTIMUM DESIGNS OF THE CLASS $q \times 3^2$

For balanced designs of the type $q \times 3^2$ in blocks of $3q$ plots each, in which the sets

" J_0, J_1, J_2 ," " J_1, J_2, J_0 " and " J_2, J_0, J_1 ," where J_0, J_1, J_2 are the three sets of treatment combinations corresponding to BC (J), are repeated t_1, t_2 and t_3 times respectively in each replication, it can be shown that the loss of information on BC and ABC is given by

$$L(BC) = \frac{t_1^2 + t_2^2 + t_3^2 - t_1 t_2 - t_1 t_3 - t_2 t_3}{q^2} \quad (3)$$

and

$$L(ABC) = \frac{3(t_1 t_2 + t_1 t_3 + t_2 t_3)}{q^2}, \quad (4)$$

where

$$t_1 + t_2 + t_3 = q,$$

the total loss of information thus being 2, which is the necessary condition for a balanced design in this case. Now q can be of the form $3t$, $3t-1$ or $3t-2$, t being any positive integer.

When $q = 3t$, the optimum design is given by

$$t_1 = t_2 = t_3, \quad L(BC) \text{ being } 0. \quad (5)$$

When $q = 3t-1$, the optimum design is given by

$$t_1 = t_2 = t, t_3 = t-1, \quad (6)$$

$$L(BC) \text{ being } 1/q^2.$$

Finally, when $q = 3t-2$, the optimum design is obtained when $t_1 = t$, and

$$t_2 = t_3 = t-1, \quad (7)$$

$$L(BC) \text{ being } 1/q^2.$$

A balanced design cannot be optimum unless each of the replications follows one of the three patterns discussed above.

The procedure of pseudo-factors discussed in Section 3 gives optimum designs for the class of $l \times 3^2$ designs in which each of the three sets " J_0, J_1, J_2 ," etc., occurs $l/3$ times in a replication and $L(BC) = 0$. It would thus follow that where resolvable BIB designs with parameters $v = l$, $k = l/3$, b , r , λ exist, these would yield optimum balanced designs of the class $l \times 3^2$. Such BIB designs are known to exist for $l = 6$, 9 and 12, which thus enables construction of optimum 6×3^2 , 9×3^2 , 12×3^2 designs in 18, 27 and 36 plot blocks respectively.

It would also be seen that where resolvable BIB designs with parameters $v = sp$, $k = p$, b , r , λ exist, these enable construction of optimum balanced designs of the class $q \times s^2$, where $q = sp$. In this manner, the designs 10×5^2 , 12×4^2 , 15×5^2 , 21×7^2 and 28×7^2 in blocks of 50, 48, 75, 147 and 196 plots respectively are readily obtained.

5. METHOD OF CUTTING

The method of cutting given by Kishen and Srivastava² and also independently by M. N. Das

(unpublished) is a useful device for obtaining balanced asymmetrical factorial designs. However, it appears that for designs of the type $q \times s^2$, where $q = sp$, p being any integer, adopting a single cut, that is, cutting out in all the blocks all the treatment combinations which contain the last level of the factor A, gives an optimum design. Thus, from 8×2^2 design given in Section 3, the optimum 7×2^2 design is obtained by omitting all the treatment combinations involving a_7 , i.e., the last row of the design. This, in fact, is the design obtained from the associated BIB design with $v = b = 7$, $k = r = 3$, $\lambda = 1$. However, when we have two cuts, that is, we omit the row containing a_6 , also in this design, the resulting 6×2^2 design is no longer an optimum design, the loss of information on BC in this design being $1/21$ when it should have been zero if it were optimum. With the adoption of three cuts, that is, omitting the row containing a_5 , also, we get a balanced 5×2^2 design which again is not optimum, the loss of information on BC being $3/35$ when this loss in the case of an optimum design is $1/25$. All these designs involve 7 replications.

From the 9×3^2 design referred to in Section 3, we can by one cut obtain the 8×3^2 design, which is optimum, the loss of information on BC in this case being $1/64$. However, with two cuts, we obtain a balanced 7×3^2 design which, however, is not optimum, the loss of information on BC being $1/28$ instead of $1/49$ if the design were optimum. With three cuts, we get a balanced design for 6×3^2 in which the loss of information on BC is $1/16$, instead of zero in the case of an optimum design. With a further cut, we obtain a 5×3^2 design in which the loss of information on BC is $1/10$ instead of $1/25$ in the case of an optimum design. All these designs have eight replications.

It would thus appear that in the case of designs of the types $q \times 2^2$, where $q = 2u$, and $q \times 3^2$, where $q = 3u$, u being any positive integer, only a single cut results in an optimum design and that further cuts yield only balanced designs which increasingly deviate from the optimum as the number of cuts adopted increases. The method of cutting is thus only useful in providing balanced designs where the corresponding optimum designs do not exist. Two or more cuts, therefore, never lead to optimum designs for the construction of which other methods, some of which have been indicated in the earlier Sections, have to be adopted. It may, however, be remarked that the optimum 5×2^2 and 9×2^2 designs in 10 and 18 blocks of 10 and 18 plots each respectively, which are non-

resolvable, can be obtained direct from the optimum 6×2^2 and 10×2^2 designs by using a single cut.

6. USE OF PBIB DESIGNS

In any asymmetrical factorial design, the use of the associated BIB design usually results in a large number of replications. It is, therefore, necessary to use the associated PBIB designs for obtaining partially balanced asymmetrical factorial designs which lead to a marked reduction in the number of replications required for a completely balanced design. Thus, for instance, the partially balanced 6×2^2 design obtained by doubling the 3×2^2 design, requires only three replications instead of five replications required for the completely balanced optimum design. It is noticeable that in this partially balanced design, BC is unconfounded. Similarly, partially balanced designs for $q \times 2^2$, where $q = 4p$ ($p \geq 2$), in three replications are obtainable from the completely balanced 4×2^2 design in three replications; and the partially balanced $q \times 3^2$ design, where $q = 3p$ ($p \geq 2$), in two replications are derivable from the completely balanced 3×3^2 design in two replications. This technique, which has been given by

Kishen and Srivastava,² thus enables a large class of practically useful partially balanced asymmetrical factorial designs to be constructed.

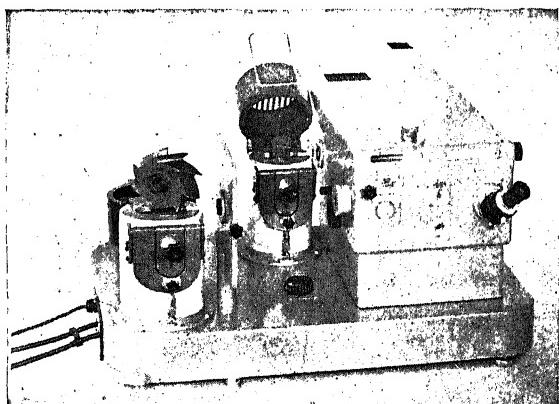
7. DESIGNS OF THE TYPE $q \times t \times s$, WHERE $t = s^n$

In this case, the $t \times s$ treatment combinations are divided into s sets corresponding to $s - 1$ degrees of freedom for the interaction BC. Then the problem of construction of optimum balanced designs in blocks of qt plots reduces to that of construction of optimum balanced designs for $q \times s^2$ in blocks of qs plots, methods of construction of which have already been discussed. Thus, for the $3 \times 4 \times 2$ design in blocks of 12 plots each, a balanced design is available, as in the case of the 3×2^2 design, in three replications. If, however, balance is desired on each of the three degrees of freedom belonging to the interaction BC, 9 replications would obviously be required.

1. Kishen, K. and Srivastava, J. N., *Curr. Sci.*, 1959, 28, 98.
2. — and —, *J. Ind. Soc. Agric. Stat.*, 1960, 11 (1 and 2), 73.
3. Kishen, K., *Curr. Sci.*, 1960, 29, 465.
4. Rao, C. R., *Sankhya*, 1961, 23 A, 117.

THE INDUSTRIAL SPECTROSCOPE

IN the pavilion of the German Democratic Republic at the Second Indian Industries Fair being held from the 14th of November 1961 until the 1st of January 1962, VEB Carl Zeiss JENA is exhibiting amongst other products of their extensive production programme the Industrial Spectroscope which deserves special mention.



The Industrial Spectroscope has been designed in a way which permits its application in the various fields of industrial material testing, primarily for rapid spectrochemical analyses for

all kinds of metals. The principal field of application for the Industrial Spectroscope is in the small and medium-sized industrial and research inspection laboratories, e.g., in metal and semi-finished product stores, in annealing and tempering plants, in scrap yards and scrap reclaiming depots, foundry laboratories, metallurgical, metallographic and mining experimental stations and similar inspection points where the speedy recognition of the material quality is frequently of great economic importance. The following technical data will indicate its optical performance: high dispersion by two double-effective flint-glass prisms, $D = 0.9 \text{ \AA/mm.}$ at $5,000 \text{ \AA}$; the resolving power $\lambda/\Delta\lambda = 17,000$ at $5,000 \text{ \AA}$ means that 0.3 \AA can still be discerned; large aperture ratio of $1:11$; two different magnifications: $\times 8$ for low-power viewing and $\times 22$ for exacting observations; direct wavelength determination to $\pm 2 \text{ \AA}$; the coarse motion ensures a rapid survey of the spectrum—precise setting with the aid of the fine motion; izochromatic photometric evaluation with a neutral wedge of high pitch, thus no loss in light-intensity by polarising filters; convenient reading of wavelengths and extinction on frosted screens; two attached spark stages within easy reach from the operator's place; rapid change of the counter-electrodes; self-contained rigid design.

EARTH TIDES

S. BALAKRISHNA

Geology Department, Osmania University, Hyderabad

AS the earth itself is an elastic yielding body, not only the marine surface, but also the earth's surface deforms due to the gravitational attractions of the sun and the moon. The elastic deformation of the earth, considered separately from the water on its surface, is called an Earth Tide. Because of its rigidity, earth will not quite reach the equipotential surface, as an ideal body of liquid of rigidity zero would do, but will assume an intermediate height, which will depend upon the elastic properties and the density of the earth. There is another factor 'g' which can be measured at any station, which is a function of density and physical properties of the material constituting the earth, in that region. In other words the deformation that the earth undergoes as a result of gravitational attraction between earth, sun and the moon are reflected in the values of 'g' at a given time. By using modern gravimeters with high sensitivity and accuracy, changes in the vertical component of earth tide, which has the amplitude of several 10^{-7} of the normal gravity unit (gal), can be recorded continuously permitting study and analysis of the gravity-time curve for a proper understanding of the problem of earth tides. The variation of the tidal forces and consequently the fluctuations in the gravity-time curve are essentially due to continuous changes in the position of the sun and the moon with respect to the earth, causing corresponding changes in the tide-generating force. A theoretical gravity-time curve can be constructed by assuming the positions of sun, moon and earth (observation point), average density of earth and a certain value for the rigidity of earth. A liquid sphere of the size and mean density of the earth, rigidity value zero and high compressibility would have a natural period of 94 minutes; on the other extreme an incompressible elastic sphere, of the density of the earth, rigidity of steel would have a natural period of 55 minutes. Earth being an intermediate case would fit into some position of the gravimetric spectrum depending upon the local geological structure. By comparing the theoretical and experimental curves and assuming certain conditions, the rigidity of earth can be approximately estimated. Study of earth tides seems to provide a powerful tool in understanding the nature and geological structure of regions where observations are being made.

As the tidal fields (variation in the Gravitational Value) are only of the order of 10^{-7} of the normal gravity field, on the earth's surface, it is a major experimental task to disentangle the different influences and to dissect the complicated observed data into different components. Experimental arrangements do not measure exclusively the primary earth tides but also some secondary effects which are mainly of oceanic origin and also include tectonic influences. The measurements therefore contain a complex sum of effects which can be characterised by vectors and the results can be expressed as a vectorial sum

$$M = KE + I + S$$

where KE is the direct effect which will be proportional to the equilibrium theoretical tide by a factor K characterised by the type of measurement and the elasticity of the earth. The indirect effects are contained in I which is of tidal periodicity and is mainly of oceanic origin, but may also include tectonic influences. S are the secondary effects, which can be written as a vectorial sum

$$S = S_g + S_m + S_t$$

where S_g is the effect of geological and tectonic structure, S_m is the meteorological pressure effect (including also maritime surges) and S_t is the effect of variations of temperature, that is, either direct effects on the instrument or secondary effects such as those due to strain influences in the earth's crust.

On the surface of the earth, observations have been made to study the variation of the numerical value of the earth's gravitational field at several points; its variation with time has been studied and causes for such variation have been analysed—the principal one caused by attraction according to Newton's Law, the second one caused by earth's rotation. The variations of the tidal forces due to the alterations of the astronomical elements of the moon and the sun can be expressed by the sums of cosine functions with constant amplitudes and frequencies, the amplitudes being only functions of the geocentric latitude of the observer and his distance from the earth's centre. The direction of the vertical component is taken as positive in the direction opposite to the normal gravitational field. The maximum of the tidal action therefore corresponds to a measured minimum of gravity.

While the semidiurnal fluctuations due to the moon and the sun are the most important, there are a great many other less important contributory factors which cannot be neglected in the understanding of the complete picture of the tidal fluctuations on the surface of the earth. Some of the most important semidiurnal and diurnal constituents which are used in the analysis of the earth tides are : Lunar Principal (M_2), Solar Principal (S_2), Lunar Elliptical (N_2), Lunisolar (K_2), Lunisolar (K_1), Lunar Declination (O_1) and Solar Declination (P_1).

The experimental data showing the variation of the vertical component of the gravity field with time can be subjected to either simple harmonic analysis, least square method or a modified Fourier Method after eliminating the drift by the Running Mean Method. The harmonically analysed results, specially the M_2 constituent, is generally the most reliable. The experimental drift-eliminated curve can now be analysed for the seven main tidal components, semidiurnal and diurnal mentioned above. The amplitudes of the seven components for both the curves can be compared and the ratio of the two amplitudes is very significant. Using this value the Rigidity of the Earth at the experimental station can be calculated. The earth tides at a particular station are dependent upon the Geological Structure, Internal Constitution of the Earth and Tectonic conditions. By comparing the experimental and theoretical tidal components we can also calculate the Phase Lag, Gravimetric Factor, Diminishing Factor, the Lambert's Constant and the three tidal Elastic Constants h , k and l , which characterise the elasticity of the earth, for a fuller understanding of the picture.

The six characteristic numbers, listed above, are functions of density and elasticity distributions in the interior of the earth. The comparison of the experimental tidal data with the values to be expected for a homogeneous, incompressible earth will show an incompatibility. In fact, taking this as a clue, several formal solutions for the inner structure of the earth have been given by many geophysicists. The influence of the oceans on the tidal values on continental stations is interesting to study. It has been observed that at a distance of 600 Kms. from the seashore the effect of the oceanic tides can be minimised to a large extent. Tomaschek summarised that the oceanic effects consist of three components : The gravitational attraction of the shifted water masses on the point of observation ; the deformation of the solid earth due to the shift of the water masses, and the

change of potential due to the changed distribution of masses.

The meteorological influences are felt mainly in the temperature and pressure fluctuations; both deform the earth's surface and the knowledge of these factors is of great importance. The main periodic influences of temperature are diurnal and to a lesser degree semidiurnal in period. Geological and tectonic structures influence the Earth Tide measurements in a double way. Firstly the stresses in the rocks, specially at greater depths, give rise to strong drift movements which make it impossible at times to obtain any reasonable results at all. Secondly asymmetric geological features in the neighbourhood, such as faults, induce periodical residual movements.

Another interesting feature in the Earth Tide study is that, an effect of the stresses which are connected with earth tides on the occurrence of earthquakes has been claimed. It has been observed that the Gravity-Time record is greatly disturbed exactly at the same time as a seismograph is affected by an earthquake occurring at stations far removed from epicenter of the order of 6000 Km. and gradually dies down. A close examination of the gravity and seismic records obtained from neighbouring observatories with reference to particular earthquake will enable us to know the local geological structure. It appears also that the long distance earthquakes can be made use of in a similar fashion for delineating the Mohorovicic discontinuity in an area.

Gravitational attraction is in the nature of constraint, tending in accordance with general theory to shorten the period. For instance, it was calculated that for a sphere of steel of the mass and mean radius of the earth, the effect of gravity would be to lower the period from about 66 min. to about 55 min. Further, as mentioned above, the effect of gravitation is to cause an initial stress in the body in its equilibrium configuration so that the body during oscillation undergoes displacements. The renewal of interest in the oscillation problem was greatly stimulated by Benioff's discovery of an oscillatory movement of period of 57 min. in the records of the Kamchatka earthquake of 1952, which he attributed to the free oscillation of the earth. On the experimental side, this suggestion has led to the building of seismographs of very long period with the object of searching for such oscillations. The free period of earth is found to be 44' 17" and more recently it was calculated to be of the order of 53.7 min. after the Great Chilean earthquake. The search in seismograph

records for evidence of free oscillations is worth pursuing on account of the light that it may throw on the mechanism of an earthquake or large explosion. A free oscillation would not continue, if damping is present, as a result of the regular periodic vibrations in the tidal gravitation potential; when very near resonance, however, a somewhat irregularly periodic disturbance would give rise to a free oscillation, and for this reason it may be worthwhile analysing runs of gravimeter observations for traces of those free oscillations.

In the Geology Department of the Osmania University, Hyderabad, an Askania Gravimeter (GS 11) has been set up, and continuous recording of gravity-time curve has been made for the last eight months. It has been noticed that earthquakes occurring in different regions of earth's crust have considerably disturbed the normal run of the curve. The extra stress energy released due to an earthquake, together with the tide-generating force seems to have considerably increased the amplitude of the curve. In fact during recent explosions made by Russian Scientists, the disturbances caused in the normal curve are remarkable and unprecedented. The duration of the disturbance, high amplitude and intensity of the curve are of special nature and stand out prominently. No

earthquake so far caused such disturbances. By comparing a month's experimental data and corresponding theoretical data, the rigidity of earth at Hyderabad has been calculated to be 4.1×10^{-11} . Several interesting conclusions have been drawn out of this earth tide data.

Studies on Earth Tides are of recent origin and in fact not many stations in the world are recording such data. It has been noticed that practically no data are available below 20° latitude. An attempt to record the gravity-time curve and analyse it in India is bound to throw some light on understanding the underground structure, of which we know very little, and also contribute to a large extent to the world data already obtained. These studies in India are very significant because observations can be made at stations where oceanic effects can be practically eliminated. Further in a shield country like India, values of rigidity are bound to be very high and an analysis of this is interesting. When comparing the values of two different stations, attention has to be paid to factors like geographical location, influence of the ocean, i.e., the distance of the ocean surface to the observation point, meteorological influences, geological and tectonic structure and finally the elastic properties of the rocks of that area.

JOURNAL OF THE GEOLOGICAL SOCIETY OF INDIA

THE Geological Society of India was founded in Bangalore in 1958, and its formal inauguration took place at New Delhi on 23rd January 1959. The Society has as its chief object the promotion of advanced study and research in all branches of geology connected with India, and this it proposes to fulfil by, amongst other activities, (1) holding seminars and symposia on topics of current geological interest and (2) publishing a periodical (for the present annual) Journal which will bring out the outstanding work done on the Geology of India and closely related fields.

The first two volumes of this Journal have now come out under the editorship of Prof. L. Rama Rao (*Journal of the Geological Society of India*, Vol. 1, 1959, Pp. 166, Price Rs. 15; Vol. 2, 1961, Pp. 103, Price Rs. 15, Bangalore-4). The contents of the two volumes speak of the high standard of the Journal and the extent of the coverage.

Volume 1 contains 14 papers. The first is a summary of the Presidential Address on "Evolution of the Desert Belt of Asia" delivered by Dr. D. N. Wadia on the occasion of the Inauguration of the Society. In this Dr. Wadia has developed his thesis that the arid zone of Afro-Asia has arisen as a reaction from the Pleisto-

cene Age of the northern hemisphere. Amongst the other articles in this volume are "The Great Vindhyan Basin of Northern India" by M. S. Krishnan and J. Swaminath. "The Source of the Deccan Trap Flows" by W. D. West and "Tertiary Stratigraphic Correlation in the Indo-Pacific region and Australia" by M. F. Glaessner.

Included in the 11 papers in Volume 2 are "Guiding principles in Stratigraphy" by H. G. Schenek. "Radioactivity of Some Rocktypes of Andhra State" by C. Mahadevan et al., "The 'Champion Gneiss' in the Archæan Complex of Mysore" by B. Rama Rao and "Petrology of the Lavas of Pavagad Hill, Gujarat" by S. C. Chatterjee.

Many of the authors who have contributed to these two volumes are well-known geologists. The subjects covered are wide in range and the standard of the articles is high. The printing and get-up of the Journal are also of high quality. There is no doubt that the publication of the Geological Society of India will serve a keenly felt want in our country and will be welcomed not only in India but also in other countries of the world where currently rapid advances in various aspects of geological studies are taking place.

LETTERS TO THE EDITOR

POTENTIAL CONSTANTS AND
THERMODYNAMIC PROPERTIES OF
 IF_5 AND IF_7

BRAUNE AND PINNOW¹ by the electron diffraction study concluded that the structure for IF_5 was probably a trigonal bipyramidal with the point group D_{3h} . Later the electron diffraction studies by Rogers, Wahrhaftig and Schomaker² and Bauer³ and nuclear magnetic resonance study by Gutowsky and Hoffman⁴ confirmed the C_{4v} model for IF_5 . Further the C_{4v} model is in accord with expected bond hybridization of d^2p^3 orbitals. Moreover Pauling⁵ has pointed out that in atoms with an unshared pair of electrons the unshared pair tends to "occupy" one of the corners of the co-ordination polyhedron as though to replace the shared pair of the bond, and that for a central atom with five bonds and one unshared pair, the five bonds should be directed toward the five corners of a square, i.e., the structure should be C_{4v} . The study of directed valence from group theory by Kimbel,⁶ Duffey⁷ and Scott⁸ the nuclear magnetic resonance study by Gutowsky and Hoffman⁴ and the electron diffraction studies by Bauer,³ Lavilla and Bauer⁹ and Burbank¹⁰ confirmed the pentagonal bipyramidal structure with the point group D_{5h} for IF_7 . Lord and his co-workers¹¹ studied the Raman and infrared absorption spectra of IF_5 and IF_7 on the basis of C_{4v} and D_{5h} models respectively and the fundamental frequencies given by them are taken now for the evaluation of potential constants on the basis of Wilson's group theoretical method¹² and the calculation of thermodynamic properties.

The selection of internal co-ordinates, construction and orientation of symmetry co-ordinates and the choice of potential function for both IF_5 and IF_7 will be published elsewhere. The molecular parameters⁹⁻¹¹ for IF_5 are $D = d = 1.75 \text{ \AA}$, $\theta = 86^\circ 12'$ and $\phi = 105^\circ$ and for IF_7 are $D = d = 1.825 \text{ \AA}$, $\theta = 72^\circ$ and $\phi = 90^\circ$. The obtained potential constants in 10^5 dynes per cm. are as follows:—
 $f_d = 3.6958$, $f_a = 3.3243$, $f_g = 0.4492$, $f'_a = 0.2816$, $f_\theta = 0.4032$, $f_\phi = 0.2518$, $f_{dd} = 0.6524$, $f_{\theta\theta} = 0.1586$ and $f_{\phi\phi} = 0.0937$ for IF_5 and $f_d = 3.4899$, $f_a = 3.0032$, $f_g = 0.5013$, $f'_a = 0.3224$, $f_\theta = 0.2519$, $f_\phi = 0.2131$, $f_{\theta\theta} = 0.2258$, $f_{dd} = 0.5824$, $f'_{dd} = 0.1541$, $f_{\phi\phi} = 0.1387$, $f_{\theta\theta} = 0.0825$ and $f_{\phi\phi} = -0.0315$ for IF_7 .

The heat content, free energy, entropy and heat capacity were calculated for this molecule for 15 temperatures from 100° to 1300° K . using the fundamental frequencies for IF_5 . A rigid rotator, harmonic oscillator model was assumed and the values were calculated for the ideal gaseous state at one atmospheric pressure. Nuclear spins and isotopic mixing were neglected. Using the above parameters the moments of inertia for IF_5 are as follows:—

$$I_{xx} = I_{zz} = 182.2727 \text{ AWU \AA}^2 \\ (302.7785 \times 10^{-10} \text{ g. cm.}^2) \text{ and}$$

$$I_{yy} = 217.322 \text{ AWU \AA}^2 \\ (360.9999 \times 10^{-10} \text{ g. cm.}^2).$$

The symmetry number is 4. The values for the thermodynamic properties for IF_5 are given in Table I. The thermodynamic functions for IF_7 have been calculated by LaVilla and Bauer⁹ by using the same fundamental frequencies used here for the calculation of potential constants and hence they need not be repeated here.

TABLE I

*Heat content, free energy, entropy and heat capacity of Iodine pentafluoride for the ideal gaseous state at one atmospheric pressure**

T ($^\circ \text{K.}$)	$(H_0 - E_0^\circ)/T$	$-(F_0 - E_0^\circ)/T$	S $^\circ$	C _p $^\circ$
100	9.046	40.412	49.458	11.827
200	12.267	47.641	59.908	18.908
273.16	14.582	51.815	66.397	22.698
298.16	15.303	53.114	68.417	23.696
300	15.363	53.220	68.583	23.769
400	17.840	57.991	75.831	26.557
500	19.768	62.204	81.972	28.186
600	21.256	65.908	87.164	29.180
700	22.431	69.271	91.702	29.819
800	23.362	72.267	95.629	30.248
900	24.159	75.112	99.271	30.561
1000	24.806	77.661	102.467	30.786
1100	25.372	80.135	105.507	30.957
1200	25.843	82.361	108.204	31.087
1300	26.255	84.489	110.744	31.180

* T is the temperature in degrees Kelvin, the other quantities are in cal. deg.⁻¹ mole⁻¹ and E_0° is the energy of one mole of perfect gas at absolute zero temperature.

The author expresses his grateful thanks to Dr. K. Venkateswarlu, for his encouragement and interest during the progress of this work and to the University Grants Commission,

Government of India, for the award of a Post-Graduate Research Scholarship.

Dept. of Physics, G. NAGARAJAN.
Annamalai University,
Annamalainagar, S. India, July 17, 1961.

1. Braune and Pinnow, *Z. Physik. Chem.*, 1937, **35B**, 239.
2. Rogers, Wharhaftig and Schomaker, *Abstracts, Atlantic City Meeting*, American Chemical Society, April 1947.
3. Bauer, S. H., *J. Phys. Chem.*, 1952, **56**, 343.
4. Gutowsky, H. S. and Hoffman, C. J., *J. Chem. Phys.*, 1951, **19**, 1259.
5. Pauling, L., *Nature of Chemical Bond*, Cornell University Press, Ithaca, New York, 1940, p. 110.
6. Kimbel, G. E., *J. Chem. Phys.*, 1940, **8**, 188.
7. Duffey, G. H., *Ibid.*, 1950, **18**, 943.
8. Scott, R. L., *Ibid.*, 1950, **18**, 1420.
9. LaVilla, R. E. and Bauer, S. H., *Ibid.*, 1960, **33**, 182.
10. Burbank, R. D., *Ibid.*, 1959, **30**, 1619.
11. Lord, R. C., Lynch, M. A. Jr., Schumb, W. C. and Slowinski, E. J., *J. Am. Chem. Soc.*, 1950, **72**, 522.
12. Wilson, E. B. Jr., *J. Chem. Phys.*, 1939, **7**, 1047; 1941, **9**, 76.

SYNTHESIS OF N-METHYL-2-AZABI-CYCLO (3, 3, 0) OCTANE

A METHOD for building *cis*-2-azabicyclo (3, 3, 0) octane ring system present in solanidine nucleus (rings D, E) has been developed. It opens up a route, starting from C_{17} carbonyl group, to synthetic azasteroids with beta C_{16} -N linkage. These bases are expected to show useful pharmacological activity but attempts to synthesise them have not been successful.¹ The method holds further promise for the total syntheses of natural solanum alkaloids.

N-methyl-cyclopentylacetamide, b.p. 148–50°/13 mm. (Found : C, 68·31 ; H, 10·56. $C_8H_{15}NO$ requires C, 68·52 ; H, 10·81%). Reduction with lithium aluminium hydride gave N-methyl-2-cyclopentylethyl amine (I), b.p. 60–61°/8 mm. in 69% yield. Picrate crystallised from ethanol, m.p. 121–121·5°. (Found : C, 47·16 ; H, 5·65 ; N, 16·05. $C_{14}H_{20}N_4O_7$ requires C, 47·34 ; H, 5·59 ; N, 15·65%).

The secondary amine I was treated with N-chlorosuccinimide to obtain the corresponding N-chloroamine (II) which was rearranged, to the isomeric C-chloramine III, in concentrated sulphuric acid. The final ring closure to the tertiary amine IV was effected with dilute sodium hydroxide solution. Picrate of amine IV crystallised from benzene, m.p. 219–219·5° (Found : C, 47·58 ; H, 5·05. $C_{14}H_{18}N_4O_7$ requires C, 47·57 ; H, 5·05%).

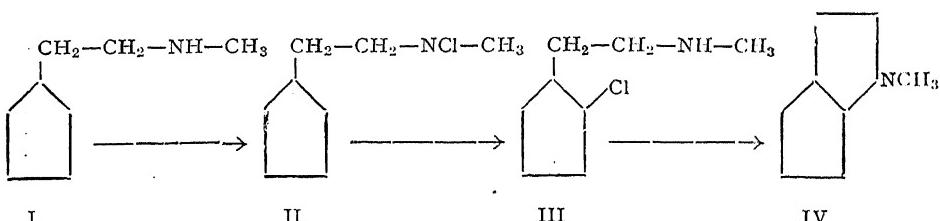
The attempted rearrangement with ultraviolet irradiation gave inferior results.

Department of Chemistry, S. V. KESSAR.
Panjab University, K. P. MAHAJAN.
Chandigarh-3, July 10, 1961. A. L. RAMPAL.

1. Gould *et al.*, *J. Amer. Chem. Soc.*, 1956, **78**, 3158.
2. Cragoe *et al.*, *J. Org. Chem.*, 1950, **15**, 381.

2:4-DINITROPHENYLHYDRAZONES OF SOME FLAVANONES

2:4-DINITROPHENYLHYDRAZONES as derivatives of the carbonyl in the benzo-pyrone system was first reported by Mozingo and Adkins¹ and subsequently by Douglas *et al.*² The work is extended to a large number of flavanones made available during the course of synthetic work



Cyclopentanone was converted into ethyl cyclopentylidenecyanoacetate in 92% yield by using Cragoe's² modification of the Cope-Knoevenagel reaction. The cyanoacetate on hydrogenation, hydrolysis and decarboxylation furnished cyclopentylacetic acid. The corresponding acid chloride was condensed with methyl amine to obtain an 84% yield of

in progress in these laboratories. It is now found that these condensations could be effected using alcoholic dinitrophenylhydrazine in presence of concentrated hydrochloric acid and the reaction was complete during 12–24 hours. These show a prominent absorption band between 400–410 $\mu\mu$. Table I gives a summary of the results obtained during this investigation.

TABLE I

2 : 4-Dinitrophenylhydrazone of	Melting point	Appearance	Analysis for Nitrogen			
			Formula	Calculated	Found	
7-Hydroxy-flavanone	..	270-71	Deep orange red needles (E.A.)	C ₂₁ H ₁₆ O ₆ N ₄	13.3	12.9
7-Methoxy-flavanone	..	259-60	Scarlet red plates (E.A.)	C ₂₂ H ₁₈ O ₆ N ₄	12.9	13.0
7-Hydroxy-6-ethyl flavanone	..	258	Orange red needles (Alc.)	C ₂₃ H ₂₀ O ₆ N ₄	12.5	12.4
7-Hydroxy-4'-methoxy-flavanone	..	223-24	Deep red plates (Alc.)	C ₂₂ H ₁₈ O ₇ N ₄	12.4	12.5
6-Hydroxy-flavanone	..	280	Orange red needles (E.A.-Alc.)	C ₂₁ H ₁₆ O ₆ N ₄	13.3	12.9
5-Methoxy-flavanone	..	250	Crimson red rectangular plates (E.A.)	C ₂₂ H ₁₈ O ₆ N ₄	12.9	12.7
5 : 7-Dihydroxy-flavanone	..	266-68	Bright red rectangular plates (E.A.-Alc.)	C ₂₁ H ₁₆ O ₇ N ₄	12.8	12.5
5 : 7-Dimethoxy flavanone	..	231-32	Scarlet red rectangular plates (E.A.)	C ₂₃ H ₂₀ O ₇ N ₄	12.1	11.8
5-Hydroxy-7-methoxy-flavanone	..	236-38	Deep red rectangular plates (E.A.)	C ₂₂ H ₁₈ O ₇ N ₄	12.4	12.3
5-Hydroxy-7-benzoyloxy-flavanone	217-18	do.	C ₂₈ H ₂₂ O ₇ N ₄	10.6	10.8	
5-Methoxy-7-benzoyloxy-flavanone	215-16	Bright red needles (E.A.)	C ₂₉ H ₂₄ O ₇ N ₄	10.4	10.6	
6-Hydroxy-7-methoxy-flavanone	..	286	Deep red rectangular prisms (E.A.)	C ₂₂ H ₁₈ O ₇ N ₄	12.4	12.4
7 : 8-Dihydroxy-flavanone	..	258	Deep red rectangular plates with a green reflex (E.A.)	C ₂₁ H ₁₆ O ₇ N ₄	12.8	12.5
7 : 8-Dimethoxy-flavanone	..	247	Orange red rectangular plates (E.A.)	C ₂₃ H ₂₀ O ₇ N ₄	12.1	12.4

E.A.: Ethyl acetate. Alc.: Ethyl alcohol.

Dept. of Chemistry, V. VENKATESWARLU.
 Andhra University, CH. BHEEMASANKARA RAO.
 July 26, 1961.

1. Mozingo, R. and Adkins, H., *J. Am. Chem. Soc.*, 1938, **60**, 669.
2. Douglass, C. D., Morris, Q. L. and Wender, S. H., *Ibid.*, 1951, **73**, 4023.

SYNTHESIS OF THIOUREIDO-TRIPHENYLMETHANES

MANY aryl isothiocyanates and thioureas are known to possess bactericidal and antitubercular activity.¹ It was of interest to prepare thioureas containing triphenylmethyl substituent and study its modifying effect on -N-CS-N- group which is primarily responsible for the activity.

Triphenylmethyl isothiocyanate was prepared according to Ilicito *et al.*² in 90% yield. This was then condensed with different amines according to the method described by Trivedi *et al.*³

Table I indicates the compounds thus prepared with necessary modifications. All thioureas were crystallised from petrol ether (60-80°) in colourless needles or platelets. All melting points are uncorrected.

Authors thank Dr. N. M. Shah for interest and the Principal for facilities.

TABLE I
 $\text{Ph} = \text{C}_6\text{H}_5 -$ $\text{Ph}_3 - \text{C}-\text{NH}-\text{CS}-\text{NH}- \text{R}$

No.	R =	Formula	M.P. °C.	Analysis % S	
				Found	Required
1	C ₆ H ₅	C ₂₆ H ₂₂ N ₂ S	82	8.0	8.1
2	p-C ₆ H ₄ CH ₃	C ₂₇ H ₂₄ N ₂ S	150-58	7.8	7.8
3	p-C ₆ H ₄ OCH ₃	C ₂₇ H ₂₄ N ₂ SO	152-53	7.4	7.5
4	o-C ₆ H ₄ OCH ₃	C ₂₇ H ₂₄ N ₂ SO	162	7.0	7.5
5	a-C ₁₀ H ₇	C ₃₀ H ₂₄ N ₂ S	80 ^a	7.1	7.2
6	B-C ₁₀ H ₇	C ₃₀ H ₂₄ N ₂ S	157-58	7.4	7.2
7	p-C ₆ H ₄ SCN	C ₂₇ H ₂₁ N ₃ S ₂	80	14.1	14.2
8	p-C ₆ H ₄ N(CH ₃) ₂	C ₂₈ H ₂₇ N ₃ S	80 ^b	7.1	7.3
9	C ₆ H ₅ NH-	C ₂₆ H ₂₃ N ₃ S	130 ^c	7.6	7.8
10	-CH ₂ COOH	C ₂₂ H ₂₀ N ₂ O ₂ S	130 ^d	8.3	8.5
11	6-C ₉ H ₅ O ₂	C ₃₀ H ₂₂ N ₂ OS (Coumaryl)	76-77	6.9	7.0
12	Diphenylamine	C ₃₂ H ₂₆ N ₂ S	130 ^e	6.6	6.8

^a Difficulty involved; required three hour reflux and repeated crystallisation.

^b Difficulty involved; required three hour reflux and repeated crystallisation.

^c Mixed melting point with isothiocyanate (138°) depressed to 80°.

^d Mixed melting point with isothiocyanate (138°) depressed to below 100°.

^e Mixed melting point with isothiocyanate (138°) depressed to 110°.

Dept. of Chemistry,
St. Xavier's College,
Ahmedabad-9, July 17, 1961.

P. R. SHAH.
J. P. TRIVEDI.

1. McKay and Garmaise, *Can. Pat. No. 579233; G.A., 1960, 54, 412; J. Am. Chem. Soc., 1959, 81, 4328; Tefas, Berechet, *Ann. Pharm. France*, 1960, 18, 37.*
2. Ilicito, Fava, *J. Org. Chem.*, 1960, 25, 1445.
3. Trivedi *et al.*, *J. Ind. Chem. Soc.*, 1956, 33, 423.

EFFECT OF GAMMEXANE ON FLAVOPROTEIN ENZYMES OF RAT LIVER

GAMMEXANE, the gamma isomer of hexachloro cyclohexane is toxic to rats at a dosage of 40-80 mg.% in the diet. (Doisy and Bocklage, 1949). Liver damage is the most prominent pathological feature in animals and human subjects poisoned with gammexane (Report to the Council on Pharmacy and Chemistry, 1951).

Xanthine oxidase and D-amino-acid oxidase are two of the important flavoprotein enzymes present in rat liver. The activity of these flavoprotein enzymes may get affected in a diseased liver brought about by gammexane intoxication. The scope of the work was therefore to study xanthine oxidase and D-amino-acid oxidase activities of rat liver when the rats were fed a diet containing gammexane in toxic amounts.

Xanthine oxidase activity in the liver of rats was estimated by the method of Litwack *et al.*, 1953. D-amino-acid oxidase activity of rat liver was estimated by Warburg's manometric method (Umbriet *et al.*, 1957) as done by Decker and Byerrum (1954).

Albino rats weighing 70 ± 10 gm. were grouped into two groups of 8 rats each. Group 1 rats which were the controls had the basal diet which contained 21% casein (devitaminised by repeated washing with rectified spirit), 65% sucrose, 7% arachis oil, 4% salt mixture (Dalglish, 1952), 1% vitamin mixture (Burch *et al.*, 1956) without inositol but with 30 mg.% of riboflavin and 2% codliver oil. Group 2 rats received the basal diet with 80 mg.% of gammexane (Doisy and Bocklage, 1949). Animals were kept on the experimental diet for 6 weeks at the end of which they were sacrificed for enzyme estimation.

Rats which received gammexane had very poor growth rate. They exhibited hypersensitivity and hyperirritability. The xanthine oxidase activity of the liver of rats receiving gammexane was inhibited to the extent of 55%. (The average xanthine oxidase activity of the liver of rats on basal diet and 80 mg.% gammexane

was $3.17 \pm 0.23 \mu$ Moles of xanthine oxidised per hour per gm. of wet liver whereas that of control rats was $7.1 \pm 0.21 \mu$ Moles.) Inhibition of xanthine oxidase activity by gammexane has not so far been reported though it has been shown that folic acid (Prema Fatterpaker and Srinivasan, 1951), (Williams, Jr., J. N., 1950), Vitamin C (Feigelson Philip, 1952), Isatin, Ninhydrin and alloxan (Bruns, 1954), inhibit xanthine oxidase activity.

The liver D-amino-acid oxidase activity of rats was not affected by gammexane intoxication.

As xanthine oxidase is a riboflavin-containing enzyme and as its activity was inhibited by gammexane, increased amounts of riboflavin (600 μ g.%) along with gammexane were given to rats for 4 weeks to find out whether increased concentration of dietary riboflavin will offset the inhibition. It was found that doubling the amount of dietary riboflavin did not correct the inhibition.

As gammexane is an antimetabolite of inositol, (Sarma, 1950; Rajalakshmi *et al.*, 1960) it was tried whether addition of inositol to the diet will reverse the inhibition of xanthine oxidase activity by gammexane. 400 mg.% of inositol given with 80 mg.% gammexane in the diet for a period of 4 weeks did not reverse the inhibition.

Summary.—Gammexane added to the diet in a concentration of 80 mg.% inhibits liver xanthine (oxidase activity of rats to the extent of 55%). This inhibition is not reversed by increased amounts of dietary riboflavin or inositol and appears to be due to direct poisoning of the enzyme. Liver D-amino-acid oxidase activity is not affected in gammexane intoxication. The two flavoprotein enzymes behave differently towards gammexane.

Dept. of Biochemistry, S. RAMAKRISHNAN.
Madurai Medical College, V. SRINIVASAN.
Madurai-2, July 3, 1961. T. M. B. NEDUNGADI.

1. Bruns, F., *Naturwissenschaften*, 1954, 41, 360.
2. Burch, H. B., Lowry, O., Padilla, A. and Combs, A., *J. Biol. Chem.*, 1956, 223, 29.
3. Dalglish, C. E., *Biochem. J.*, 1952, 52, 3.
4. Decker, L. E. and Byerrum, R. V., *J. Nutrition*, 1954, 53, 303.
5. Doisy, Jr., E. A. and Bocklage, B. C., *Proc. Soc. Exp. Biol. Med.*, 1949, 71, 490.
6. Feigelson Philip, *J. Biol. Chem.*, 1952, 197 (2), 843.
7. Litwack, G., Bothwell, J. W., Williams, Jr. J. N. and Elvehjem, C. A., *Ibid.*, 1953, 200, 303.
8. Prema Fatterpaker and Srinivasan, A., *Nature*, 1951, 167, 149.
9. Rajalakshmi, S., Srinivasan, V. and Sarma, P. S., *Proc. Soc. Exp. Biol. Med.*, 1960, 104, 97.

10. "Report to the Council on Pharmacy and Chemistry," *J.A.M.A.*, 1951, **147**, 571.
11. Sarma, P. S., *Curr. Sci.*, 1950, **19**, 315.
12. Umbriet, W. W., Burris, R. H. and Stauffer, J. F., *Manometric Techniques*, 1957, 3rd Edn.
13. Williams, Jr. J. N., *J. Biol. Chem.*, 1950, **187**, 47.

INFLUENCE OF HOST PLANTS ON THE AMINO-ACID MAKE-UP OF *SANTALUM ALBUM LINN.*

ALTHOUGH *Santalum album* Linn. has long been recognised as an obligate root parasite,¹⁻³ the nature and degree of its dependence upon its host plant has not been precisely and fully elucidated. Venkata Rao's⁴ observation that the leaves of sandal plants growing in forest areas in close proximity to strychnos plants, tasted characteristically bitter, suggested that the sandal might be drawing from its host fully or partially elaborated sap constituents. Later⁵ sandal plants grown in big 40 gallon steel drums with strychnos and melia plants exclusively as the respective host plants, showed that in both cases the bitter principles had been transferred to the sandal leaf. The absolute identity of the bitter principles derived from the leaves of sandal and from the host, has not, however, been established.

The present communication deals with a chromatographic study of the amino-acid make-up of the 12-month-old sandal plants raised in the nursery in pots in association with different host plants, *Acacia farnesiana*, *Sesbania grandiflora*, *Pongamia glabra*, tomato and *Lantana camara*; leaves from sandal plants growing slowly without any host plant, and also leaves from the respective host plants, have been studied.

Leaf material consisting of the third leaf from the growing tip, was collected from the nursery and immediately ground up and extracted with 70% v/v ethanol acidified with acetic acid. The brei was centrifuged at 3,000 RPM for 30 minutes and the clear supernatant, 10 µl, was streaked on rectangular strips of Whatman No. 1 filter-paper 570 × 165 mm. Chromatograms were developed by the downward flow of the solvent mixture composed of butanol, acetic acid-water 4 : 1 : 5, at room temperature, 24–26° C. The runs were completed usually in about 30 hours. After air-drying, the chromatograms were sprayed with 0.1% ninhydrin in butanol and dried in an oven for 10 minutes.

A careful reading of the chromatograms revealed that the leaves from sandal plants, without any host plant, had practically no basic amino-acids although they had a heavy concentration of oxyproline. Leaves from sandals, growing

in association with leguminous plants which are good hosts, showed high concentrations of the basic amino-acids. Leaves from sandals nourished by non-leguminous hosts which are poor, like tomato and lantana, had only a relatively low proportion of the basic amino-acids. In fact, the rate of growth of sandal plants appeared to be roughly related to the concentration of the amino-acids furnished by the host plants. Sandal without a host plant lacks the mechanism to synthesise the basic amino-acids, which are intimately connected with the genetic material make-up and function of all organisms. The sandal is dependent upon its host plant for the supply of these basic amino-acids.

The chromatograms also show that the sandal plant is capable of synthesising oxyproline in appreciable quantities without any host plant. Most of the host plants, so far investigated, have not revealed the presence of any oxyproline in their leaves although proline is definitely present.

Further work on the quantitative aspects of the problem is in progress. Our thanks are due to Dr. P. S. Rao and Dr. M. N. Ramaswamy, for their kind interest.

Forest Res. Lab., R. A. SRIMATHI.
Malleswaram, Bangalore-3, D. R. C. BABU.
November 14, 1961. M. SREENIVASAYA.

1. Barber, C. A., *Memoirs, Dept. Agri. India*, 1906, 1, No. 1.
2. —, *Indian Forester*, 1905, **31**, 189.
3. Rama Rao, M., *Ibid.*, 1903, **29**, 248.
4. Venkata Rao, M. G., Private Communication, 1928.
5. Sreenivasaya, M., *J. Indian Inst. Sci.*, 1931, **14 A**, 59.

REVERSIONS IN DRUG RESISTANCE OF *VIBRIO CHOLERAE*

INCIDENCE of bacterial resistance to drugs has been well established by a number of workers in recent years. The bacterial geneticists tend to believe the theory of spontaneous mutation and selection rather than a direct induction of resistance due to the effects of drugs. The two ideas have later been complemented¹ on the basis of differential selection due to differential inhibition and Lamarckian inheritance of resistance² in bacteria has been widely accepted. In a detailed study to evaluate the chemotherapeutic importance of chloramphenicol against *Vibrio cholerae* which is being worked out in this department, it was found necessary to investigate into the stability of resistant forms of *V. cholerae* emerging out of the effect of the drug. The present experiment, worked out with 200 µg./ml. chloramphenicol resistant *V. cholerae*,

obtained through 'single step' and 'multiple step' treatments, showed varying degrees of reversions in resistant *V. cholerae*.

The culture used in this experiment was a typically flagellated strain of *V. cholerae*, isolated from a human carrier and obtained from the School of Tropical Medicine, Calcutta. It was found to be sensitive to chloramphenicol (2 µg./ml.) *in vitro*. Resistance in *V. cholerae* to 200 µg./ml. of chloramphenicol was induced in a 'single step' and in 'multiple steps'. 'Single step' resistance was induced by keeping the organism in contact with the drug (200 µg./ml.) for 72 hours in absence of bacterial multiplication by suspending the cells in phosphate buffer at pH 7.0. 'Multiple step' resistance was induced through serial transfers in nutrient broth with higher amounts of antibiotic. Five successive generations of the two resistant varieties obtained from the two sources were examined for stability and reversions and the mean of counts from five generations has been graphically represented. Survival was counted by turbidimetry after an incubation of 4 hours at 37°C.

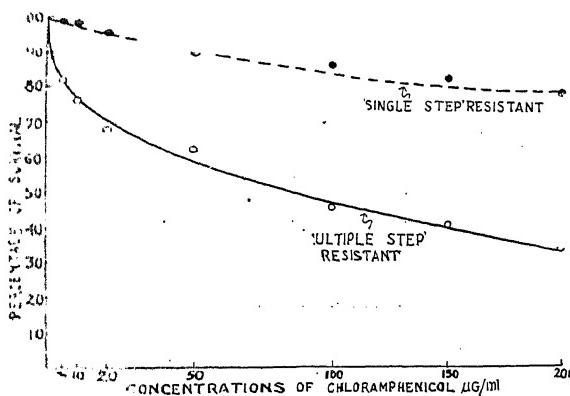


FIG. 1. Percentage survival of resistant (200 µg./ml.) *Vibrio cholerae* indicating reversions at different concentrations of chloramphenicol. The data represent a mean of five generations.

From the data it is observed that the rate of reversibility is more rapid in 'multiple step' resistant forms than those induced in a 'single step' where the mutant is more stable. If the theory of spontaneous mutation and subsequent selection is accepted, the drug must have acted on different loci at different concentrations, thus involving different genes in developing resistance. But the mechanism seems to be somewhat similar in both cases, since the nature of the two reversion curves follows the same tendency. Higher stability in 'single step' resistant forms may only be explained in terms of muta-

tion of some additional genes which remained stable and lost the power of back mutation in them.

In the light of our present knowledge of reversions in induced mutants^{3,4} where mutation frequency in measurements of reversions varied widely (which in some instances reached as high as 80%), many different mutations of uncertain genetic status were observed as compared to the more restricted assay when using reversions under conditions of controlled genetics. In drug resistance also it is possible that mutations of uncertain genetic status are evolved which may explain the difference in the shape of mutation-reversion curves, as observed in this case.

Department of Microbiology, P. M. NAHA.*
Bose Institute,
Calcutta-9, June 10, 1961.

* Present address; Central Rice Research Institute, Cuttack, Orissa.

1. Watanabe, T., Fukasawa, T. and Ushiba, D., *J. Bact.*, 1957, **73**, 770.
2. Szybalski, W., *Antibiotics Ann.*, 1954-55, **2**, 174.
3. Giles, N. H. Jr., *Cold Spring Harbour Symposium Quant. Biol.*, 1951, **16**, 283.
4. Newcombe, H. B. and Whitehead, H. A., *J. Bact.*, 1951, **57**, 243.

AN IMPROVED BASAL MEDIUM FOR THE MICROBIOLOGICAL ASSAY OF RIBOFLAVIN USING *LACTOBACILLUS CASEII*

WHILE assaying samples of potatoes for riboflavin using the medium of Snell and Strong (1939), it was observed that the unknowns consistently produced dose-response curves with much steeper slopes than those for the standards and this necessitated a re-examination of the medium to determine whether it was "complete" for the test organism, *L. caseii*. Earlier modifications in the composition of this medium (Greene and Black, 1943; *Pharmacopeia of the U.S.A.*, XII, 1943; Roberts and Snell, 1946; Clarke, 1953) have not proved very successful in extending the range of linearity in the dose-response curve beyond 0.0-0.2 µg. dose levels of riboflavin, although the sensitivity of the assay was markedly improved.

The nutritional requirements of *L. caseii*, as understood at present (Snell, 1945), is much more complex than those for the other species of the genus. Recent work on the improvements of the medium has taken cognisance of the essential, rather than the stimulatory nature of some of the members of the group of B vitamins, other than riboflavin. Assays with trial media

proved that for the maximum elongation of the linear portion of the dose-response curve, supplementary doses of calcium pantothenate, *p*-aminobenzoic acid, pyridoxine hydrochloride, biotin and folic acid, in addition to an increase in the concentration of glucose and yeast extract solution, three-fold and five-fold respectively, as in the Snell and Strong medium, were essential. The final medium adopted had the following composition:—

TABLE I
Composition of the improved basal medium

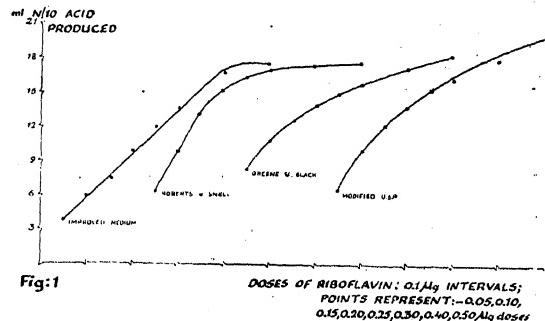
Constituents	Amount per 100 ml. double strength medium
Alkali-treated, photolysed peptone (DIFCO) gm.	1.0
Yeast extract (OXO), lead-acetate- treated, gm.	1.0
Glucose, anhydrous, gm.	6.0
Sodium acetate, gm.	1.2
Cystine, mg.	100
Inorganic salts, mg.	..
Salts A:	
KH_2PO_4	100
K_2HPO_4	100
Salts B:	
$\text{MgSO}_4 \cdot 7 \text{H}_2\text{O}$	40
$\text{MnSO}_4 \cdot 4 \text{H}_2\text{O}$	2
$\text{FeSO}_4 \cdot 7 \text{H}_2\text{O}$	2
NaCl	2
Vitamin supplements, $\mu\text{g}.$	
Calcium pantothenate	20
<i>p</i> -aminobenzoic acid	20
Pyridoxine hydrochloride	20
Biotin	0.08
Folic acid	0.016

The peptone and yeast extract solutions were prepared by the procedure of Snell and Strong (1939), with this slight modification that light exposure period for the alkali-treated peptone solution was extended to 36 hours to eliminate riboflavin completely. The vitamin supplements were dispensed from a stock solution in 25% ethyl alcohol.

The comparative performance of this medium with those of Roberts and Snell, Greene-Black, and modified U.S.P. (Clarke, 1953) was studied and tests for the precision of the assay worked out. The assay procedure was essentially the same as that of Snell and Strong as modified by collaborative study (Snell, 1950).

The stock culture was *L. caseii*, ATCC 7469. Stab transfers were made weekly in glucose-agar-yeast extract (Pennington *et al.*, 1940), but were passed through an enrichment medium containing fresh liver extract as recommended by Nymon and Gortner (1946), once a month to maintain the vigour of the culture.

The dose-response curves obtained with the four media are presented in Fig. 1. The statisti-



cal data for the evaluation of the response curves are given in Table II.

TABLE II
Evaluation of response curves

	Improved medium	Roberts & Snell	Modified U.S.P.	Greene- Black
Approximate range of linearity, $\mu\text{g}.$	0.05– 0.40	0.05– 0.20	0.10– 0.25	0.10– 0.20
Maximum N/10 acid produced, ml.	17.4	17.3	19.9	18.3
Variance for differ- ence btween dupli- cates, sampling error, s^2	0.081	0.098	0.103	0.094
Slope of curve, b	38.46	41.02	36.20	33.00
Expected precision of bioassay employ- ing linear portion of curve, $s/b = \lambda$	0.0074	0.0077	0.0089	0.0091

The data show that the improved medium is superior to the others tested, for the following reasons: (i) the blank titre value is very low; (ii) the value of λ is the lowest, which gives it the greatest precision, and (iii) the range of the linear portion of the dose response curve is the longest, i.e., 0–0.4 μg . riboflavin.

The author wishes to place on record his grateful thanks to Dr. Pushkarnath, Director, Central Potato Research Institute, for the facilities provided and to Dr. V. S. Krishnamachar of the National Chemical Laboratories, Poona, for supplying the type culture of the organism and for helpful guidance.

Central Potato Res. Station, K. SWAMINATHAN,
Patna, June 1, 1961.

1. Bliss, C. I., "Statistical Methods in Vitamin Analysis," in P. Gyorgy, Ed., *Vitamin Methods*, Academic Press, New York 1951, 2.
2. Clarke, M. F., *Anal. Chem.*, 1953, 25, 1247.
3. Greene, R. D. and Black, A., *J. Am. Pharm. Assoc. Sci. Ed.*, 1943, 32, 217.

4. Nyman, H. C. and Gortner, W. A., *J. Biol. Chem.*, 1946, **163**, 277.
5. Pennington, D., Snell, E. E. and Williams, R. J., *Ibid.*, 1940, **135**, 213.
6. Roberts, E. C. and Snell, E. E., *Ibid.*, 1946, **163**, 429.
7. Snell, E. E., *Advances in Protein Chem.*, 1945, **2**, 85.
8. —, "Microbiological Methods," in P. Gyorgy, Ed., *Vitamin Methods*, Academic Press, New York, 1950, **1**.
9. — and Strong, F. M., *Ind. Engg. Chem., Anal. Ed.*, 1939, **11**, 346.
10. *United States Pharmacopoeia XII*, First Bound Supplement, 1943, p. 79.

A PRELIMINARY NOTE ON THE CHEMICAL AND PHARMACOLOGICAL EXAMINATION OF STREBLUS ASPER LOUR.*

Streblus asper Lour. is a small tree indigenous to tropical India. It belongs to the family Urticaceae. The decoction of its bark is given in fever, dysentery and diarrhoea, while the root is described to possess antiseptic and astringent properties.¹ However, it was brought to our notice that the decoction of the leaves of this plant is prescribed in the treatment of high blood pressure, and also for easy painless quick delivery during labour.

In the course of the routine pharmacological screening of the leaves and roots of the plant, the total alcoholic extract particularly of the root bark was found to indicate interesting activity on blood pressure, isolated frog heart, isolated rabbit intestine and guinea-pig uterus. It was therefore taken up for detailed investigation.

The dried root-bark, after initial treatment with petrol, was extracted with 90% alcohol at room temperature. The extract was concentrated under reduced pressure, and then freed from the chlorophyllous and other inactive impurities. It showed the presence of glycosides, free sugars, tannins and KCl; tests for alkaloids were negative. The clear filtrate was then extracted with chloroform, which yielded the active principle in the form of a creamish-yellow coloured powder. It was extremely bitter to taste and was highly hygroscopic. It was purified by taking in water and re-extracting the clarified water solution with chloroform. It was finally obtained in the form of beautiful white rosettes crystallised from sulphuric ether in a dry atmosphere. It melts at 160° C. It has a molecular formula $C_{19}H_{28}O_6$; contains one OC_2H_5 and one CCl_3 group, and 2 or 3 'active hydrogen'. It is soluble in most of the solvents, except petrol; it is more soluble in water and chloroform. With acetic anhydride and conc. H_2SO_4 it gives a play of colours, colour-

less—pink—green; it decolorises $KMnO_4$ and Br_2 -water; it reduces Tollen's reagent slowly. It was found to be an α,β -unsaturated lactone.

When examined pharmacologically, this lactonic substance showed interesting activity of a marked degree. Administered by the intravenous route the LD₅₀ in white mice (average weight 18–21 gm.) is about 4·8 mg./kg. Initial symptoms of acute clonic convulsions followed by a short period of lethargy are the principal toxic manifestations. In urethan anaesthetized rabbits doses between $5 \cdot 10^{-8}$ and $5 \cdot 10^{-7}$ induce prolonged hypotensive response preceded by an acute pressor effect, associated with an enhanced respiratory rate, the higher $5 \cdot 10^{-7}$ dose being lethal. Studied on isolated frog heart (*R. tigrina*) it induces a positive inotropic effect in 10^{-6} dilution and a systolic response in 10^{-4} dilution. The *in vitro* spasmolytic effect of the compound as judged on the smooth musculature of the rabbit intestine and guinea-pig (virgin) uterus is pronounced in that high dilutions between $5 \cdot 10^{-8}$ and $5 \cdot 10^{-7}$ produce tonic contractions, reversible on washing.

This pronounced action on the smooth musculature including the cardiotonics shows the possibility of the substance being developed into a drug.

Scientific Department, F. FERNANDES
CIBA of India Limited, V. N. KAMAT,
Bombay-1, October 3, 1961 S. S. BHATNAGAR.**

* This work was carried out during the period September 1955–May 1956.

** Present address: Caius Research Lab., St. Xavier's College, Bombay 1.

1. Chopra, R. N. and others, *Glossary of Indian Medicinal Plants*, 1966, 235.

DEVELOPMENT AND VIABILITY OF EGGS PRODUCED IN *CORCYRA CEPHALONICA* STAINT. FOLLOWING ADMINISTRATION OF ANTIBIOTICS

SEVERAL reports^{1–3} have appeared where feeding antibiotics to animals including insects had, on some occasions, stimulated growth but on others remained ineffective or even deleterious to them. The present communication deals with the measurement of the effect of dietary penicillin, oleandomycin and terramycin on growth and hatchability of eggs in *Coreyra cephalonica* Staint.

Single pair bred culture of *Coreyra* was employed in this experiment. The culture was successfully raised on crushed 'juar' (*Sorghum vulgare*) in 8" × 6" jars at temperatures ranging between 85° F. and 95° F. For experimental purposes 10" × 2" glass vials were filled with 120 g.

of crushed 'juar'. Weighed quantities of the antibiotics, penicillin, oleandomycin and terramycin were incorporated in the diet by thoroughly distributing the premix in the vials containing the food. Premix was prepared in glucose in convenient amounts for efficient mixing. The control groups received an equal amount of glucose only in diet. Twenty-five freshly laid eggs (24 hours' layings) were introduced in the experimental vials containing different levels of the various antibiotics. Four replications were used for each treatment. For comparison of the overall development, growth index⁴ was calculated. The index was obtained by dividing the percentage of moths that emerged (N) by the average time taken to complete development (Av). The greater the value of the index, the better was the development of the insect.

Moths emerging from the different treatments were paired within the same lot. Single pairs were confined in glass vials 8" × 2" for egg laying. These vials contained thirty small pieces of black paper rolled in balls of the size of 'juar' seed. No food was supplied to the moths. Twenty-five eggs from each of the four replications were taken out at random making a total of hundred eggs from a particular treatment. The lots of hundred eggs each from all treatments were kept separately for incubation in 10" × 2" glass vials with some quantity of crushed 'juar'. The data on hatchability and development were regularly recorded. The results of study are presented in Tables I and II.

It is evident from Table I that penicillin effected more successful emergence of this insect at the levels of application from the 50 p.p.m. to 500 p.p.m. At 1,000 p.p.m. level the growth was retarded. Oleandomycin gradually suppressed growth with the increasing rate of application. Terramycin enhanced the growth

TABLE II
Effect of antibiotics on the viability of eggs of *Corcyra cephalonica*

Supplement p.p.m.	Penicillin Viable eggs %	Oleandomycin Viable eggs %	Terramycin Viable eggs %
50	57	62	84
100	57	64	81
500	54	78	79
1,000	51	51	78
Control	66	65	80
95% C. I. Limit	56 to 75	55 to 74	71 to 87

of this insect at all levels of application. The increased growth response, however, gradually slowed down with the higher doses of the intake of this antibiotic. Data summarized in Table II reveal that penicillin reduced the viability of eggs at 500 p.p.m. and 1,000 p.p.m. levels. Oleandomycin increased the viability at 500 p.p.m. level but reduced it at 1,000 p.p.m. level. Terramycin did not produce any effect on the viability of eggs.

Grateful thanks are due to Dr. B. K. Srivastava, Entomologist to the Government of Rajasthan, Jobner, for guidance and to Principal V. V. John for providing necessary facilities and encouragement. Gift of the antibiotics through M/s. Dumex Private Ltd., Bombay, is thankfully acknowledged.

Department of Zoology, DAYA BHANU,
M.B. College, Udaipur (Rajasthan),
June 9, 1961.

- Jukes, T. H., Stokstad, E. L. R., Taylor, R. R., Cunha, R. R., Edwards, T. J., H. M. and Meadows, G. B., *Arch. Biochem.*, 1950, **29**, 452.
- Roine, P. and Ettala, T., *Nature*, 1952, **169**, 1014.
- Saxena, H. C. and Srivastava, B.K., *Sci. and Cult.*, 1960, **25**, 538.
- Singh, K. R. P. and Pant, N. C., *Zool. Soc. India*, 1955, **1** (2), 156.

TABLE I
Effect of antibiotics on the development of *Corcyra cephalonica*

Lot No.	Suppli- ment p.p.m.	Penicillin				Oleandomycin				Terramycin			
		Adult emer- gence (N)	Average time taken for com- plete develop- ment in days	Growth Index N/Av.	Adult emer- gence (N)	Average time taken for com- plete develop- ment in days	Growth Index N/Av.	Adult Emer- gence (N)	Average time taken for com- plete develop- ment in days	Growth Index N/Av.	Adult Emer- gence (N)	Average time taken for com- plete develop- ment in days	Growth Index N/Av.
1	50	40	33-54	38.45	1.04	36	41-58	41.71	0.87	65	35-51	42.19	1.54
2	100	16	33-48	38.46	0.68	27	40-51	43.52	0.62	61	36-66	41.39	1.47
3	500	34	33-46	37.70	0.90	18	40-66	44.89	0.4	54	35-55	42.17	1.28
4	1,000	22	34-41	37.45	0.59	18	41-57	46.00	0.39	50	37-55	42.38	1.18
5	Control	26	33-48	38.61	0.67	39	41-54	44.59	0.88	45	35-66	41.33	1.09

METACHROMASIA OF EARTHWORM EGGS

KELLY^{1,2} has studied metachromasia in several animals from annelids, molluscs, echinoderms, arthropods and some chordates. As most of the animals selected by him are marine, it is felt that a study of metachromasia in the eggs of freshwater and land animals, will be of interest, and the present note contains a report on the metachromasia of the eggs of the earthworm, *Pheretima elongata* (Perrier).

Ovaries of the earthworm were used for this study. The living material was observed when vitally stained. Some of the material was fixed for the preparation of permanent slides. Kahle's fluid, 4% formalin, acetic alcohol (3 : 1) and alcohol were used for the preparation of squashes and sections, though the first was found to be the most suitable. Toluidine blue (B.D.H.) was used for vital staining and for staining of fixed material. Solutions of the dye in saline were used for vital staining, the dye concentration being 0.3 mg. per 100 ml. Fixed material was routinely stained with 0.3% toluidine blue. Only a very small amount of metachromasia was lost during alcohol dehydration. Stained material was studied by sunlight and unfiltered tungsten light.

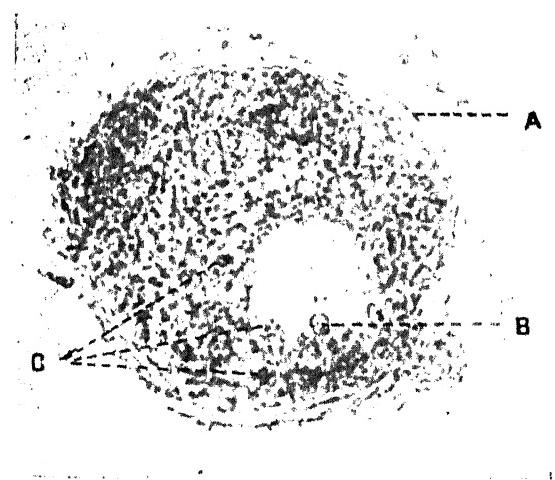


FIG. 1. Earthworm egg to show metachromasia. Vital staining by toluidine blue (0.3 mg. % in saline) jelly layer (A), nucleolus (B) and small homogeneous granules are metachromatic (pink) and ringed granules (C) are orthochromatic (blue), $\times 290$.

The study of the fully developed eggs of the earthworm after being vitally stained by toluidine blue revealed several features (Fig. 1). Two types of rounded bodies could be made

out in the cytoplasm one was smaller, appeared homogeneous and was stained metachromatically (a beautiful pink) by toluidine blue; the other was larger, gave a ringed appearance and was stained orthochromatically (blue). Mitochondria could be seen as continuously moving granules which were not stained, so also the vacuoles. No nuclear metachromasia was demonstrated as particularly observed in sectioned material except for a weak pink colour developed occasionally in the nucleolus. When the fixed material was stained with concentrated (0.3%) toluidine blue, the whole egg was stained an intense purple colour. This colour was to a large extent stable to alcohol dehydration. Jelly layer covering the egg was also lightly metachromatic.

From the study of photomicrographs, published by Kelly^{1,2} of the eggs of different marine annelids, it seems that the earthworm egg, in the present investigation, is more intensely metachromatic, particularly the bodies mentioned above. The small and homogeneously metachromatic bodies seem to correspond to L_1 bodies of Nath *et al.*³ On the other hand the other type of bodies which are larger, vesicular and stained blue orthochromatically appear to be similar to L_2 bodies described by Nath *et al.*

In the work cited above, Nath *et al.* have applied PAS (Periodic Acid Schiff) test to the eggs of the earthworm, *Pheretima posthuma*, and on the basis of negative results claim that there are no mucopolysaccharides present in their L_1 and L_2 bodies. This test was repeated in the case of the earthworm under study (*i.e.*, *Pheretima elongata*) with similar results. On the other hand the development of metachromatic colour in the smaller homogeneous bodies (L_1 bodies of Nath *et al.*) indicates the presence of mucopolysaccharides. These contrary results could be reconciled only if one were to note that while the mucopolysaccharides in general are metachromatic to toluidine blue and are PAS positive, one of them, according to Jorpes *et al.*,⁴ is metachromatic but PAS negative, *viz.*, fully substituted (sulphated) heparin. Thus the presence of heparin or heparin-like substances is indicated in the strongly metachromatic smaller homogeneous bodies while the occasionally visible weaker metachromasia of nucleolus is due to nucleic acid (RNA). This finding is also supported by Kelly.^{1,2}

The presence of easily demonstrable heparin or heparin-like substances in the earthworm eggs is significant because according to colloid chemical theory of Heilbrunn⁵ heparin has an

inhibitory effect on cell division in the eggs of lower animals.

One of us (D. N. K.) thanks the Ministry of Scientific Research, Government of India, for a grant-in-aid.

Department of Zoology,
N. Wadia College, Poona-1,
July 4, 1961.

P. V. JOSHI.
D. N. KAMAT.

1. Kelly, J. W., *Protoplasma*, 1950, **39**, 386.
2. —, *Ibid.*, 1954, **43**, 25.
3. Nath, V., Gupta, B. L. and Manocha, S. L., *Quart. J. Micro. Sci.*, 1958, **99**, 475.
4. Jorpes, J. E., Weiner, B. and Aberg, B., *J. Biol. Chem.*, 1948, **176**, 277.
5. Heilbrunn, L. V., *An Outline of General Physiology*, 3rd Ed., Philadelphia, 1952.

STEMPHYLIUM AND PSEUDOSTEMPHYLIUM

OUR present knowledge of the phæodictyous Hyphomycete genus *Stemphylium* Wallr. is due to Wiltshire.¹ This genus is based on *S. botryosum* Wallr.² In *S. botryosum*, as described by Wiltshire from type material, the spores are oval or somewhat angular, phæodictyous without a beak, often constricted at the median transverse septum and produced singly and acrogenously on the conidiophore which is typically swollen at the tip. It was stressed that the conidiophore grew through the conidial scar and produced a second conidium and that this process was repeated. Wiltshire discussed the position of *Stemphylium* as used by Harz, Oudemans, Bolle and others and indicated that in "Stemphylium" of these authors the spores were phæodictyous and acrogenous but were produced at the tip of the conidiophore and its successive growing points which arise sympodially but not by growth through conidial scars as in *S. botryosum*. Accordingly, Wiltshire classified these species showing typical sympodial growth of the conidiophore in a subgenus *Pseudostemphylium*; species similar to *Stemphylium botryosum* were classified in the subgenus *Eu-Stemphylium*. A typical geniculate conidiophore with scars is characteristic of *Pseudostemphylium*. It is now recognized that the method of spore formation is important in the taxonomy of Hyphomycetes and therefore the subgenus *Pseudostemphylium* Wiltshire is here raised to generic rank:

Pseudostemphylium (Wiltshire) Subramanian gen. nov.

= Subgenus *Pseudostemphylium* Wiltshire, *Trans. Brit. mycol. Soc.*, 1938, 21, 223.

Pertinet ad Fungos Imperfectos, ad Hyphomycetes, Phæodictyas. Mycelium hyalinum vel

fuscum, constans e hyphis septatis, ramosis. Conidiophori fusci, surgentes ut ramuli ex hyphis vegetativis, simplices, nonnumquam furcati, septati, apicibus haud distincte tumescientibus ut in *Stemphylio*. Conidia formæ variabilis, ut plurimum ovata, haud rostrata, phæodictya, vulgo non constricta ad septum maius medium, singula vel botryose fasciculata insidentia conidiophoris, acrogena, lateraliter translata ob renovationem incrementi conidiophorum ex puncto sub ipsa cicatrice conidii delapsi et ob formationem successivam conidiorum acrogenam e novis incrementi punctis; conidiophoris raro crescentibus per cicatricem delapsi conidii.

Fungus imperfectus, Hyphomycete, phæodictyæ. Mycelium hyaline to dark coloured, composed of septate, branched hyphæ. Conidiophores dark coloured, arising as branches from vegetative hyphæ, simple, sometimes branched, septate, with tips not markedly swollen as in *Stemphylium*. Conidia variable in shape, mostly ovate, not beaked, phæodictyous, usually without constriction at major median septum, borne singly or in botryose clusters on conidiophores, acrogenous, displaced laterally due to renewed growth of conidiophore from a point below scar of fallen conidium and formation of successive conidia acrogenously from the new growing points; conidiophore seldom growing out through scar of fallen conidium.

SPECIES TYPICA

Pseudostemphylium lanuginosum (Harz)
Subramanian comb. nov.

= *Stemphylium lanuginosum* Harz, *Bull. Soc. imper. Moscou*, 1871, 44 (1), 132, pl. 3, fig. 1.

= " *Mystrosporium lanuginosum* Harz", *lapsus calami* in Saccardo, *Sylloge Fungorum*, 1886, 4, 546.

OTHER SPECIES

Pseudostemphylium consortiale (v. Thuemen)
Subramanian comb. nov.

= *Macrosporium consortiale* v. Thuemen, 1876, *Herb. myc. oecon.* No. 450.

Pseudostemphylium radicum (Meier, Drechsler & Eddy) Subramanian comb. nov.

= *Alternaria radicina* Meier, Drechsler & Eddy, *Phytopathology*, 1922, 12, 157-66.

= *Thyrospora radicina* (Meier, Drechsler & Eddy) Neerg., *Bot. Tidsskr.*, 1938, 44, 359-62.

= *Stemphylium radicum* (Meier, Drechsler & Eddy) Neerg., *Aarber. fra J. E. Ohlsens Enkes Plantepat. Lab.* 1939, 1 April 1938-31 March 1939, pp. 16.

Pseudostemphylium consortiale and *P. radicum* are known from India.

I am grateful to the Rev. Fr. Dr. H. Santapau for the Latin translation of the diagnosis of the new genus.

Dept. of Botany, C. V. SUBRAMANIAN.
University of Rajasthan,
Jodhpur, October 3, 1961.

1. Wiltshire, S. P., *Trans. Brit. mycol. Soc.*, 1938, 21, 211.
2. Wallroth, E. G., *Fl. crypt. German.*, II, 1833, 2, 300.

NOTULAE EMBRYOLOGICAE

I. The Functions of Endosperm in *Avicennia officinalis*

THE endosperm of seed plants is described generally as the nutritive tissue of the embryo.¹ Considering variations in the behaviour of endosperm among angiosperms, much remains to be said. The exact role played by this tissue towards the nutrition of the embryo varies from species to species. It is well known that in exalbuminous seeds the developing embryo dissolves most of the endosperm. On the contrary, albuminous seeds possess a considerable mass of this tissue which is utilized by the embryo at the time of germination. However, the situation in a viviparous mangrove is exceptional regarding the development, functions and final fate of the endosperm.

In the early development of endosperm of *Avicennia*² it has been noticed that the endosperm tissue grows out of the ovule and lies free in the loculus. The embryo is carried out of the ovule along with the developing endosperm. At a later stage the embryo frees itself from the surrounding endosperm and comes to lie free in the loculus. However, a contact is established between the embryo and endosperm through the massive suspensor² (Fig. 1). The most important consideration here relates to the absence of reserves in the endosperm at any stage of development. Furthermore, it has been observed that the endosperm cells function as conductive structures facilitating the transport of nutrients from the aggressive endosperm haustorium to the suspensor. Consequently certain endosperm cells situated between the tip of the haustorium and the suspensor elongate considerably and therefore appear to be better suited for conduction. Such an internal differentiation in the endosperm tissue is probably caused by a localised diffusion of hormones from the developing embryo.

Presumably very large amounts of nutrients pass from the placental tissues to the embryo through the haustorium, endosperm and the sus-

pensor. That it is so is evidenced by the fact that the embryo develops into a seedling before being detached from the parent tree. The phenomenon of vivipary involves continuous development of the zygote into a seedling without a period of rest. The visible expressions

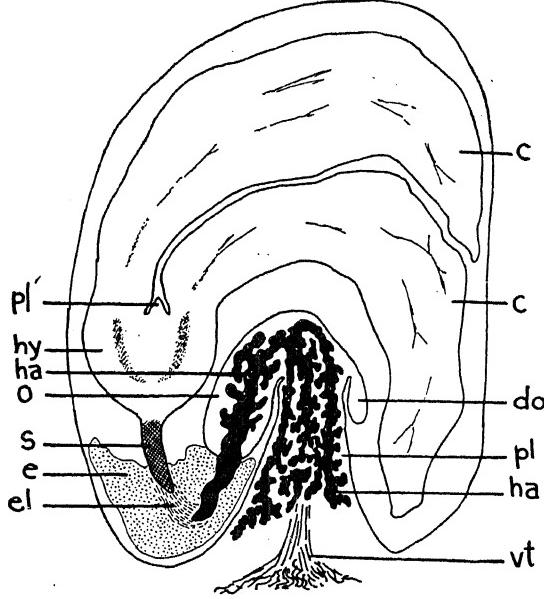


FIG. 1. L.S. of fruit showing the position of the embryo in relation to other structures. *c*, Cotyledon; *do*, degenerating ovule; *el*, elongating conducting cells of the endosperm; *ha*, haustorium; *hy*, hypocotyl; *o*, ovule; *pl*, placental column; *pl'*, plumule; *s*, suspensor; *vt*, vascular tissue of the placenta.

of such a pattern of development are to be seen in the expansion of the cotyledons, the development of the plumular leaves and the complete maturation of the vascular elements in the axis, cotyledons and the first pair of epicotylary leaves. The large quantity of nutrients supporting the growth of the embryo into a massive seedling are obviously transported through the endosperm. There appears to be no need for deposition of reserves in the endosperm cells themselves. It has also been observed that reserves are not deposited in the embryonal tissues as in exalbuminous seeds either. Furthermore the endosperm fails to grow beyond a certain volume and is found in mature fruits as a small whitish mass adjoining the placental column. It is of interest to investigate whether the absence of stored reserves either in the endosperm or in the embryo is a characteristic feature of other viviparous mangroves also. The essential features of vivipary in

Avicennia lie in the fact that the endosperm is mainly a conductive tissue.

Department of Botany, B. G. L. SWAMY.
Presidency College, D. PADMANABHAN.
Madras, October 6, 1961.

1. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, McGraw-Hill, N.Y., 1950.
2. Padmanabhan, D., *J. Madras Univ.* (in Press).
3. Swamy, B. G. L. and Padmanabhan, D., *Phytopathology* (in press).

CRITERIA FOR GRADING RESISTANCE OF SUGARCANE VARIETIES TO RED ROT (*GLOMERELLA TUCUMANENSIS*)

In India, red rot develops in the standing cane and the grading of varieties for resistance to the disease is done in terms of 'average lesion length' by what is known as the 'plug method'.¹ Examination of several hundred varieties over a number of seasons at this Institute has shown that the length of the lesion produced in a host variety is highly variable and therefore the criterion is unsatisfactory for assessment. It could not be otherwise as the disease syndrome is controlled by both plasmatic and mechanical resistance, more so by the former, and lesion length is at best a rough expression of the latter. The different characters of the syndrome were scored in 681 varieties examined between 1958 and 1960 in order to assess their relative importance in relation to overall damage.

The mechanical resistance which is located at the nodes comprises, (i) the ramification of vascular elements and heavy lignification of ground tissue which bar, to a greater or lesser extent, the transnodal extension of the primary lesion, and (ii) occurrence of septa in the water-conducting vessels which controls the migration of conidia and the consequent occurrence of secondary lesions. The plasmatic type of defence consists of a hyperergic reaction resulting in production of gums in advance of the hyphae thus controlling the destruction of sacchariferous ground tissue and enzymatic inversion of sucrose. This type of resistance is reflected in the width of the lesion and the nature and amount of white spot development therein. Thus, the primary characters which appeared to indicate resistance were (1) width of lesion, (2) occurrence and nature of white spots and (3) the degree of nodal transgression.

Certain additional characters appeared important but they occurred only in some varieties and, when they occurred, confirmed the

reaction indicated by the primary characters. In pithy varieties the pathogen was observed to destroy the pith rapidly and occupy the central core of the cane. In susceptible varieties it debouched into the parenchyma in the upper internodes, but in resistant varieties was contained by a severe gummy reaction of the fringe of parenchyma cells. Occurrence and type of nodal necrosis and development of cavities in the growth ring were other characters infrequently observed.

It was found that the scores for the three primary characters were highly correlated and the large number of varieties examined fell in only a few grades. Identical grades were obtained in the case of 127 varieties scored in 1957-58 and 554 varieties scored in 1959-60. It was observed that yellowing and drying of tops within the normal period of incubation was characteristic of only the highly susceptible grade which had a combination of the worst scores for all the characters, making it unnecessary to score such varieties for the various characters. Repetition of the test in the case of 77 varieties in a subsequent season showed that their reactions were constant, the degree of resistance of 17 varieties departing by just one step into the neighbouring grade.

Comparison of the grades of 127 varieties of 1957-58 according to the above criteria and those by the average lesion length method revealed wide divergence. Indeed, some of the varieties classed as susceptible by the criteria outlined here were resistant or moderately resistant by the average lesion length method. There could be no doubt of their grades since such varieties, when allowed to stand for a further period, showed signs of distress with yellowing and drying of tops. It is likely therefore, that the failure under cultivation of certain varieties passed as resistant after artificial inoculation might be due to the application of the unsatisfactory criterion of average lesion length in grading resistance, although, in some cases, failure due to the appearance of new, more virulent pathogenic strains in nature may not be ruled out.

A full account of the study with a detailed key for grading resistance based on the above characters is under publication elsewhere.

Sugarcane Breeding Institute, K. V. SRINIVASAN.
Coimbatore, August 31, 1961. N. R. BHAT.

1. Chona, B. L., *Indian J. agric. Sci.*, 1954, 24, 301.

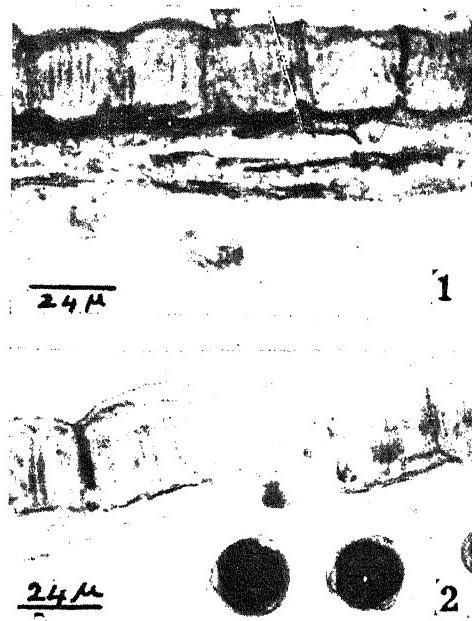
FIBROUS THICKENINGS IN THE ANTER EPIDERMIS OF *WORMIA BURBIDGEI* HOOK.

THE structure of the anther wall has been well described. Maheshwari¹ has mentioned several interesting variations that are seen in epidermis, endothecium and middle layers. In the majority of angiosperms, the anther wall has an epidermis and a prominent endothecium with fibrous thickenings at the time of dehiscence. Endothelial cells with spiral thickenings are presumed to function in the dehiscence of the anthers, bringing about the dissemination of pollen grains. Some species lack fibrous thickenings in the endothelial layer, others have thickenings on the cell-walls of middle layers of the anther. Still other species have fibrous thickenings in the cells of both endothecium and middle layers.

During an embryological investigation of Dilleniaceæ an unusual structure of anther epidermis was observed in *Wormia burbridgei* Hook. Sections which were cut at $5-10\mu$ showed that at the time of dehiscence the mature anther wall has a prominent epidermis, with or without a poorly retained endothecial layer. The epidermal cells are filled with tannin, while the outer cell-wall is cutinized (Fig. 2). In the thinner sections either very little tannin was visible, or sometimes the tannin deposit was absent. In these sections the fibrous thickenings were clearly seen. These do not develop in the cells of the endothecium, even if that tissue is present at the time of dehiscence. The development of the fibrous thickenings was studied in transverse as well as longi-sections of the anthers. The epidermal cells accumulate tannin material even before the differentiation of microsporocytes. Attempts to dissolve and remove the tannin from these cells by treating them with FeCl_3 and lead nitrate were partially successful in young as well as mature anthers (Figs. 1 and 2).

As far as the author is aware this is the first instance where the fibrous thickenings have been observed in the epidermal cells of the anther. There is no mention of such a feature in the previous literature on the embryology of Dilleniaceæ.²⁻⁶ However, the presence of a prominent epidermis has been recorded in all the species that are investigated so far. In case of *W. burbridgei* and *Dillenia*^{5,6} the endothecium lacks the fibrous thickenings even when it is persistent at the shedding stage. In *Hibbertia stricta* the endothelial cells are fibrous; and only some of the cells have fibrous thickenings in *H. billarderii*.⁶ In *Acrotrema arnottianum*⁴ also only some endothelial cells develop fibrous

thickenings as in *H. billarderii*. In order to determine the exact variation of the occurrence of fibrous thickenings in the wall layers of the anther the other genera of the family are being studied. The indefinite hypogynous stamens in



FIGS. 1-2. Longisections of young and mature anther wall in *Wormia burbridgei*. Note the absence of tannin in one of the cells in Fig. 2.

W. burbridgei are basally fasciculate; and they dehisce by the formation of apical pores at the free end of stamens. Similar conditions have been reported for several species of *Wormia*.^{7,8} The formation of fibrous thickenings in the epidermal wall of the anthers may function to provide mechanical strength for the anther; and the endothecium does not take part in the dehiscence of the anthers.

Department of Botany,
University of Malaya,
Singapore-10, July 3, 1961.

A. N. RAO.

1. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, New York, 1950.
2. Schnarf, K., *S. B. Skad. Wiss. Wien.*, 1924, 17, 133.
3. Paetow, W., *Planta*, 1931, 14, 441.
4. Swamy, B. G. L. and Periasamy, K., *Phyto-morphology*, 1955, 5, 301.
5. Nagaraja Rao, A., *Proc. Iowa Acad. Sci.*, 1957, 64, 172.
6. Sastri, R. L. N., *Bot. Notiser*, 1958, 111, 495.
7. Ridley, H. N., *The Flora of Malay Peninsula*, Reeve & Co., London, 1922.
8. Hooker, W. J., *The Flora of British India*, Reeve & Co., London, 1922.

**THE STANDARDISATION OF
SAND CULTURE TECHNIQUE FOR THE
STUDY OF MACRO AND MICRO-
NUTRIENT (TRACE) ELEMENT
DEFICIENCIES UNDER INDIAN
CONDITIONS**

IN SPITE OF the great utility of the sand culture technique¹ in elucidating problems of macro and micronutrient requirements of plants and of nutrient availability in soils, apart from some sporadic work,^{2,3} no systematic investigation has been undertaken to standardise the technique under Indian conditions; almost no information is available on the suitability of any Indian sand for micronutrient studies. Owing to the difficulty in eliminating contaminants and the preponderance of fine particles, sand from river-beds was not found suitable for refined culture work.

Extensive trials⁴ showed that water washed silica sand of the grain size 0.25 to 0.84 mm., obtained from the sandstone beds in Allahabad and Banda, in U.P., could be used as a suitable basic material, the white sand being preferred to tinted as the latter contained as much as 1440 p.p.m. iron compared to 75 p.p.m. in white sand. The purification procedure of the sand comprised one or more of the following: (i) cold treatment with 4% HCl; (ii) hot treatment with 17% HCl; (iii) hot treatment with 17% HCl and 1% oxalic acid; (iv) hot treatment with 2% KOH. Hot treatment was given by passing steam generated in an autoclave for 4 hours at a pressure of 20 lb./sq. inch in sand-acid/-alkali mixture contained in wooden vats or large clay pots painted with bitumen. With treatment (i) mild and with treatment (ii) severe effects of the deficiencies of K, Ca, Mg, P, S and N were obtained in cucurbits, brassicæ, legumes, cereals, etc.⁴ Severe deficiencies of iron in barley, radish, cauliflower and mungel wurzel and of boron in cucurbits were obtained by giving treatment (iii) twice. By giving treatment (iii) thrice and treatment (iv) twice in the order (iii), (iv), (iii), (iv), (iii) severe copper deficiency was obtained in barley (Fig. 1) and manganese deficiency in oats, barley, paddy and mungel wurzel (Fig. 2). In the former the last step of sand purification was carried out in pyrex glass containers.

For obtaining macronutrient, iron, boron and manganese deficiencies clay flower pots painted thrice with bitumen and water passed through 3 deionising units, each containing a column of Zeocarb and De-Acedite resins were suitable. Pyrex containers were required for obtaining

acute effects of manganese and copper deficiencies; the latter also required deionised water which had been distilled in all pyrex glass containers. Free drainage was provided and appropriately purified nutrient solutions applied daily



FIGS. 1-2. Fig. 1. Copper deficient plants of barley showing death of the growing points, failure to unroll and withering of young leaves. The older leaves are green and plants bushy in appearance. Fig. 2. Manganese deficient mungel wurzel plant showing mottled upright leaves, triangular in outline owing to forward curling of leaf margins.

instead of a few times^{2,3} in the growing season in order to maintain the nutrient supply at a known desired level. The full nutrient solution contained: K, 156; Ca, 160; Na, 31; Mg, 48; P, 55; S, 64; N, 168; Fe, 5.6; Mn, 0.55; Cu, 0.064; Zn, 0.065; B, 0.37; Mo, 0.05; Co, 0.006; and Ni, 0.006 p.p.m.

Department of Botany,
Lucknow University,
Lucknow, April 25, 1961.

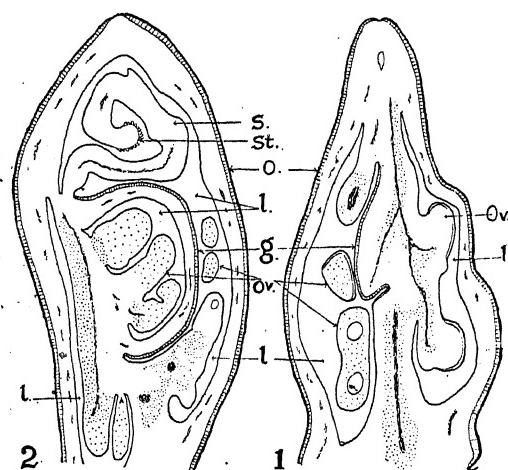
S. C. AGARWALA.
C. P. SHARMA.

1. Hewitt, E. J., *Sand and Water Culture Methods Used in the Study of Plant Nutrition*, C.A.B. Bucks, England, 1952.
2. Misra, G. and Samantrai, B., *J. Indian bot. Soc.*, 1955, **34**, 451.
3. Sircar, S. M. and Sen, N. K., *Indian J. Agric. Sci.*, 1941, **11**, 193.
4. Agarwala, S. C. and Sharma, C. P., Unpublished.

**A GYNOECIUM IN THE OVARY OF
RHINANTHUS MAJOR EHRH.**

WHILE working on the embryology of *Rhinanthus major*, two interesting cases of a gynoecium inside the ovary were observed. In a cross section the normal ovary is biconvex, discoid; having axile placentation and two compressed loculi. There are about seven disc-shaped ovules in each loculus, arranged alternately in two rows. The ovule is attached with a nodular funiculus to a similarly shaped region of the placenta. Reduction in the number of the ovules and their curious disposition so as to have the maximum advantage of the available space in the loculus, makes the embryology of this plant very interesting. Further studies are in progress and will be published elsewhere.

The tissue of the placenta, in the two abnormal cases, develops an ovary on it. It arises as a compact, elongated structure (Fig. 1) and is bounded by a conspicuous epidermis filled with a brownish substance, simulating the epidermis of the parent ovary. A cavity arises in this structure which on its floor bears a number of apparently normal ovules (Fig. 2). Anatomy of the envelope that covers these ovules is similar to that of the parent ovary wall. Hence, this new structure is interpreted as an ovary within an ovary. Furthermore, from its apex, it develops a long coiled style bearing a characteristic stigma (Fig. 2). As the abnormal ovary develops, the two loculi of the original ovary are more or less reduced in size and one may be partly obliterated (Fig. 2). It is not certain whether the abnormal gynoecium proliferates in order to expose its stigma to the pollen grains. The cavity of the ovary, however, communicates with the loculus in which it develops through an opening at the base of its style where it is detached from the placenta. It is likely therefore, that the pollen tubes entering the loculus may also reach to the ovules covered over by the abnormal ovary.



Figs. 1-2. *Rhinanthus major* Ehrh. Abnormal ovaries, $\times 22$. Fig. 1. L.S. ovary; note the ridge-like initial of another ovary on the placenta. Fig. 2. Same, abnormal gynoecium. (g = abnormal ovary; l = locule; O = ovary; ov = ovule; S = style; St = stigma.)

Abnormalities of a similar nature in the reproductive organs of the flower have been reported in a number of plants. To mention a few of them: Farooq¹ found on the gynoecium of *Citrus medica* attached anthers and 'extra ovarian ovules' and Shukla³ described an attached stamen and an 'extra locular ovule'

on the ovary wall of *Peganum hermala*. In this plant he also noted an open carpel having a stamen attached to the carpillary margin which ascends up to the stigma. Johri and Tiagi² observed pollen mother cells and pollen grains in the ovary wall of *Cuscuta reflexa*.

We are grateful to Prof. C. V. Subramanian for encouragement and to Dr. Y. D. Tiagi of the Sagar University for the material of *Rhinanthus*.

Department of Botany,
University of Rajasthan,
Jodhpur,

B. TIAGI.
KAMAL MOHNOT.

- August 29, 1961.
1. Farooq, M., *Curr. Sci.*, 1952, **21**, 72.
 2. Johri, B. M., *Phytomorph.*, 1952, **2**, 162.
 3. Shukla, R. D., *J. Indian bot. Soc.*, 1955, **34**, 382.

THE EFFECT OF GROWTH-REGULATING SUBSTANCES OF THE ROOT EXTRACT OF WATER HYACINTH (*EICHORNIA SPECIOSA* KUNTH.) ON JUTE (*CORCHORUS CAPSULARIS* LINN.)

THE presence of growth-regulating substances in the root extract of water hyacinth has been indicated previously from this laboratory (Sircar and Kundu, 1959, 1960; Chakravarty, 1960). The exact chemical nature of the substances present in the root is not yet known. Chromatographic separation of the extract has shown the presence of several substances including indole compounds, but one of them separated at R.f. different from indoles and gibberellins has shown remarkable properties of increasing both root and shoot growth at the same concentration (Sircar and Roy, 1961). Pending chemical identification it is felt desirable to study the effect of the extract as a whole on growth and fibre production in jute. Accordingly a pot culture experiment has been carried out in the experimental garden of the Department of Botany, University of Calcutta.

Pure line seeds of jute were sown in earthenware pots containing garden soil and leaf manure. The seedlings were subsequently thinned to two plants per pot. Twenty plants were taken in each of the treatments. Root extract of water hyacinth prepared according to the method described previously (Sircar and Kundu, 1960) was sprayed once a week to the foliar parts of ten days old plants by means of a Holm's atomiser. The height, basal circumference of the stem, number of leaves and nodes were recorded at regular intervals. The fibre of the plants was extracted by chemical treatment. The results are presented in Table I.

TABLE I

Height and basal circumference (in cm.), number of leaves and nodes and fibre yield (in gm.) of jute (*Corchorus capsularis* Linn.) after treatment with root extract of water hyacinth (RWH). Average of twenty plants

	No. of days after first application								Quantity of fibre per plant	Percentage of fibre against fresh weight of plant
	21	28	35	42	49	56	63	70		
<i>Shoot Height</i>										
RWH	..	72.0	90.11	115.08	135.17	149.91	178.68	202.94	220.88	9.40
		±0.37	±0.19	±0.56	±0.40	±0.64	±0.42	±0.72	±0.77	±0.63
Control	..	63.42	75.20	99.23	117.80	131.44	156.08	179.07	199.00	6.60
		±1.24	±0.65	±0.66	±0.81	±0.83	±0.90	±0.80	±0.89	±0.92
<i>Basal Circumference</i>										
RWH	..	2.36	3.14	3.78	4.36	5.02	5.76	6.98	7.59	..
		±0.01	±0.02	±0.02	±0.09	±0.12	±0.10	±0.12	±0.24	..
Control	..	2.20	2.66	3.07	3.68	4.16	4.90	5.35	6.12	..
		±0.03	±0.10	±0.12	±0.23	±0.05	±0.06	±0.19	±0.19	..
<i>No. of leaves</i>										
RWH	..	26.85	32.65	39.45	446.80	0.25	59.10	68.10	80.30	..
		±0.16	±0.15	±0.31	±0.11	±0.21	±0.07	±0.10	±0.18	..
Control	..	25.75	30.00	35.00	40.45	44.05	50.20	57.95	68.15	..
		±0.31	±0.27	±0.14	±0.15	±0.20	±0.18	±0.32	±0.27	..
<i>No. of nodes</i>										
RWH	..	21.95	28.85	34.00	41.55	44.25	54.30	62.10	74.25	..
		±0.82	±0.34	±1.01	±0.77	±0.53	±0.69	±0.15	±0.88	..
Control	..	21.05	27.40	32.10	38.35	40.21	45.00	52.31	63.04	..
		±0.43	±0.48	±0.69	±0.82	±0.21	±0.12	±0.16	±0.14	..

The height of the plants is increased after treatment with the root extract (RWH). During the first two to three weeks of application the plants were indistinguishable from the control, the difference becoming prominent from the fourth week onwards. The basal circumference (thickness) of the stem is markedly increased (Fig. 1). The total number of leaves and nodes on the main stem show an increase over the untreated plants. Abscission of leaves was prevented to a considerable extent by this treatment. No marked change in the shape and size of the leaves is observed. The quantity of fibre production and its percentage against the fresh weight are greater than the control.

These preliminary results from a pot culture experiment appear interesting and are likely to be of economic importance. It may be mentioned here that the effect of gibberellic acid on increased growth and fibre production of jute plants has been previously reported (Sircar and Chakravarty, 1960), but the obvious limitation in the use of gibberellic acid is the high price and difficulty in production from the fungus *Gibberella fujikuroi* (Saw.) Wr. The separation and identification of the active compound from the root of water hyacinth is worth pursuing further to determine its utility as a

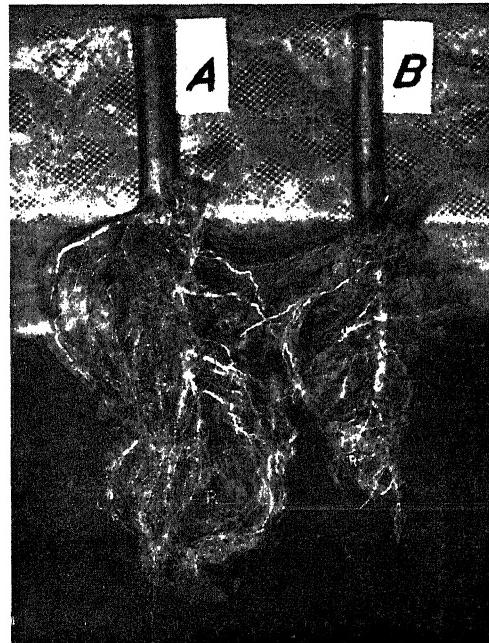


FIG. 1. Showing basal circumference (thickness) of the stem of jute plants at harvest. Treatments : A=RWH and B=Control.

growth-regulating substance. Work in this direction is now in progress in this laboratory.

Department of Botany, S. M. SIRCAR.
Univ. College of Sci., ROTHIN CHAKRAVARTY.
35, Ballygunge Circular Road,
Calcutta-19, June 26, 1961.

1. Chakravarty, Rothin, *M.Sc. Thesis*, University of Calcutta, 1960.
2. Sircar, S. M. and Chakravarty, Rothin, *Sci. & Cult.*, 1960, **26** (3), 143.
3. — and Kundu, M., *Ibid.*, 1959, **24**, 332.
4. — and —, *Physiol. Plant.*, 1960, **13**, 56.
5. — and Roy, A., *Nature*, 1961, **190**, 1213.

PTERIDOPHYTES OF NAGPUR

THE neighbourhood of Nagpur is an ideal place for systematic botanical exploration. Particularly, the pteridophytes of this region have received very scanty attention.

As a result of their own investigations, the authors are in a position to present here the following data (Table I) about the representation of these plants in the flora of this part of our country.

TABLE I
Division : Pteridophyta

Class	Order	Family	Genus	Species	Locality
1 Equisetinae	1 Equisetales	1 Equisetaceae	1 <i>Equisetum</i> L.	1 <i>E. debile</i> Roxb.	1 Ambazeri 2 Koradi
2 Lycopodinae	2 Isoetales	2 Isoetaceae	2 <i>Isoetes</i> L.	2 <i>I. coromandelina</i> L.	1 Umred 2 Mansar
3 Filicinae	3 Ophioglossales	3 Ophioglossaceae	3 <i>Ophioglossum</i> L.	3 <i>O. nudicaule</i> L. 4 <i>O. fibrosum</i> Schum.	Ambazeri Seminary Hill
	4 Filicales	4 Polypodiaceae	4 <i>Adiantum</i> L. 5 <i>Cheilanthes</i> Sw. 5 Marsileaceae	5 <i>A. lunulatum</i> Burm. 6 <i>C. tenuifolia</i> Sw. 6 <i>Marsilea</i> L. 6 <i>Salvinia</i> Lam.	Common Ramtek Common Common
			7 <i>M. minuta</i> L. 8 <i>M. quadrifolia</i> L. 9 <i>A. pinnata</i> R. Br.	7 <i>M. minuta</i> L. 8 <i>M. quadrifolia</i> L. 9 <i>A. pinnata</i> R. Br.	Common

Of these, *Azolla pinnata* R. Br. and the two species of *Marsilea* L. are very common and abundant. *Adiantum lunulatum* Burm., though not so abundant, is also not uncommon here. *Equisetum debile* Roxb. and *Isoetes coromandelina* L., which have a restricted distribution, grow in great abundance at their places of occurrence. Still less frequent and very rare are the two species of *Ophioglossum* L.

Department of Botany, M. V. MIRASHI.
College of Science, S. A. PARADKAR.
Nagpur, July 12, 1961.

SPOROPHYTE OF JUNGERMANNIA VIRIDIS KASH.

WHILE making collection of mosses at Nainital the author came across some plants of *Jungermannia viridis* with young sporophyte. As far as is known to the author only the gametophyte of this liverwort has been described (Kashyap and Chopra, 1932) and no reference is available of its sporophyte. The plants were brought to the laboratory and cultured in petri-dishes on sand medium. The plant resumed their normal growth and the young sporophyte developed to maturity.

The archegonia are born at the apex of the female plant forming a terminal cluster subtended by the perianth. Their size varies from $140-160\mu$ in length and $24-32\mu$ in breadth at the base (Figs. 4 and 5).

Only one sporophyte grows to maturity occupying the terminal position (Fig. 2). It is differentiated into foot, seta and capsule. When young it is enclosed by the perianth and calyptra. At this stage the seta is very short. A young capsule is whitish with a purple tint at the base, becoming globose, reddish to dark-brown at maturity and attaining a diameter of $0.5-0.9$ mm.

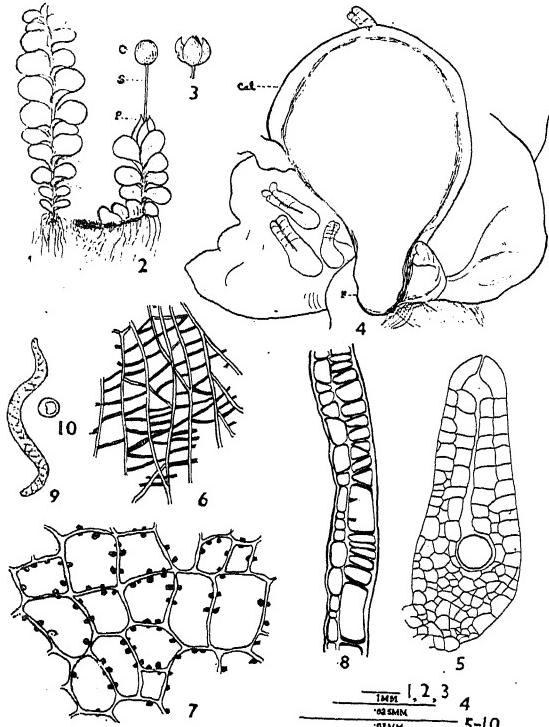
At maturity the seta elongates rapidly raising the capsule much above the perianth. The seta generally attains a length of 4 mm.

The liberation of spores is effected by the dehiscence of the capsule into four valves to the base (Fig. 3). No other special mechanism of spore dispersal is observed. The wall of capsule is two layers in thickness, the outer having columnar thickenings which appear nodular in surface view. Inner layer is provided with semi-anular thickenings (Fig. 6).

The spores are yellow to light-brown in colour, globose, $10-16\mu$ in diameter (Fig. 10).

Elaters are long with blunt ends, having bispiral thickening (Fig. 9). They are 90–110 μ long and 8 μ broad. The spore elater ratio is 2 : 1.

Department of Botany,
University of Saugar,
Sagar, M.P., April 24, 1961.
C. K. C. S. PILLAI.



FIGS. 1-10. *Jungermannia viridis* Kash. Fig. 1. Sterile shoot. Fig. 2. Female shoot with mature sporophyte: *P*, perianth; *S*, seta; *C*, capsule. Fig. 3. Dehiscence of capsule. Fig. 4. Young capsule, archegonia are also seen. *F*, foot; *Cal*, calyptra. Fig. 5. Archegonia with fertilized egg. Figs. 6-7. Inner and outer layers of capsule wall. Fig. 8. C.S. of capsule wall. Fig. 9. Elater. Fig. 10. Mature spore.

The author is grateful to the late Prof. S. K. Pande for suggesting and taking keen interest in this investigation.

1. Kashyap, S. R. and Chopra, R. S., *Liverworts of the Western Himalayas and the Punjab Plain—II*, Lahore, 1932.

A VIRUS DISEASE OF *ODONTONEMA NITIDUM*

THREE varieties of the ornamental shrub *Odontonema nitidum* (Jacq.) Kuntze are usually found in South Indian gardens. One variety has variegated leaves with bright-yellow netted veins (Fig. 1). The leaves of another variety are dark-purplish on the upper surface and purple-coloured on the lower surface (Fig. 2), while the third variety has reddish-green leaves with wavy margins and blotched with green.

The netting of the leaves in the first variety mentioned above has generally been considered a genetic variation. However, a close examination of the vein-clearing symptoms made us suspect that this might be due to infection by a virus. Experiments were, therefore, conducted to ascertain whether the variegation was transmissible. Mechanical inoculation with sap from yellow-netted variety on the purple-leaved variety was not successful. Twigs from the yellow-netted variety were, therefore, wedge-grafted on the purple-leaved variety and the wavy-margined variety. All the leaves from the stock varieties were clipped off immediately after grafting. In about four weeks young leaves emerging from the stock varieties showed faint-yellow netting. The netting became more conspicuous as the leaves matured. The scions were clipped off a few days after the grafts had established. The plants have continued to produce yellow-netted leaves with purple background (Fig. 3).



FIG. 1

FIG. 2

FIG. 3

FIGS. 1-3. *Odontonema nitidum*. Fig. 1. Yellow-netted variety. Fig. 2. Purple-leaved variety. Fig. 3. Netting produced on purple-leaved variety as a result of graft inoculation.

Similar grafts were made on *Adhathoda vasika* Nees. plants. The grafts were successful, but the netting was not transmitted.

Two viruses which cause yellow net symptoms on their hosts have been described by Sylvester (1948 and 1954). These are the beet yellow net virus (Sylvester, 1948) and the tomato yellow net virus (Sylvester, 1954). The former was not sap-transmissible while the latter was apparently so. Both were transmitted by *Myzus persicae* (Sylvester, 1949, 1954). It is not possible to say whether the present virus is related to the above two without further experiments, which are in progress. A vector for the present virus, if present in nature, does not appear to be very efficient, as no natural transmission of the disease has been observed, even though the purple-leaved variety and the netted variety are generally grown in close proximity in gardens. The virus is in the meanwhile tentatively named the *Odontonema yellow net virus*.

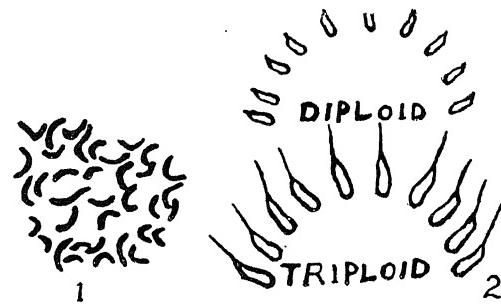
Plant Pathology Section, K. RAMAKRISHNAN,
Agricultural College and C. P. SUBRAMANIAN.
Research Institute,
Coimbatore-3, February 27, 1961.

Sylvester, E. S., *Phytopathology*, 1948, 38, 429.
—, *Ibid.*, 1949, 39, 117.
—, *Ibid.*, 1954, 44, 219.

AN AUTO-TRIPLOID OF RICE AND ITS PROGENY

In a culture of rice, *O. sativa* (Orissa improved variety T. 1242), an off type semisterile plant with large tip awned spikelets was observed. This rice plant was isolated and somatic chromosome number determined. Since considerable difficulty was experienced in getting proper spreading and staining of chromosomes, pretreatment of root-tips in cold water with alphabromo-naphthalene for 10-15 minutes was adopted. Meiosis was also studied in the PMC of this culture fixed in propionic alcohol (1 : 3) containing a trace of ferric acetate and smears were prepared in propionic-carmine. As shown in Fig. 1, the somatic chromosome number was found to be 36, showing that it was a triploid, since the diploid number in *O. sativa* is 24. Such spontaneous triploids have been obtained previously in rice by Morinaga¹ as well as by Ramanujam² and these authors have concluded that such triploids had probably originated by union between a normal and an unreduced gamete. The effect of triploidy on the different plant parts, spikelets and pollen sterility is characteristic in rice as in other crops. In the present

instance, triploidy was correlated with increase in plant height, as well as in ligule and spikelet sizes. The rice variety T. 1242 is nearly awnless, with occasional occurrence of tip awns. A comparison of the spikelets from the normal diploid plant and from the triploid plant is presented in Fig. 2.



In meiosis, 12 trivalents can be expected but is usually not found. The frequency of trivalents as determined from 50 cells gave a mean of 9.4 per cell. There is variation from a maximum of 12 trivalents to 8. The frequency of trivalents, bivalents and univalents observed is given in Table I.

TABLE I

No. of cells	Trivalent (III)	Bivalent (II)	Univalent
6	12	..	..
4	11	1	1
8	10	2	2
22	9	3	3
10	8	4	4
Mean per cell	9.4	2.5	2.5

Fertility of pollen was estimated to be 20% as determined by iodine staining, in a sample of 2907 pollen grains. Spikelet fertility was comparatively lower, being below 5% in the main crop season. The germination of the seeds collected was poor and survival of the seedlings was also poor. Both these features can be expected from the triploid nature of the plant. Ramanujam² has already recorded that aneuploid progenies are obtained on open pollination of triploid rice cultures and that plants having chromosome number in excess of $2n=26$ have retarded growth. Since aneuploids of crop plants are of theoretical interest, excised embryos were germinated in the nutrient agar media, as suggested by Randolph.³ This technique proved to be useful and can be used on a large scale. However, in the first attempt, only three adult plants labelled as A, B and C were grown to maturity. The somatic

chromosome number in these was found to be $A = 24 + 2$, $B = 24 + 2$ and $C = 24 + 3$. Meiotic studies are being used for identification of the type of aneuploidy. It is well known that two aneuploids having same chromosome number may be entirely different, since the extra chromosomes could be different members of the genome. The next step is to identify which of the chromosomes are present in excess, and this is being done by studying the pairing behaviour at meiosis in the aneuploid plants. The significance of the present work is in the application of embryo culture technique for securing new primary trisomics of rice and this work is being continued.

This work was carried out at the Central Rice Research Institute, Cuttack and the author is indebted to the Director for facilities and to Shri S. Sampath for guidance, and to the State Department of Agriculture, Mysore, for the deputation.

Agric. Res. Station,
Nagenahalli, Mysore-3,
March 10, 1961.

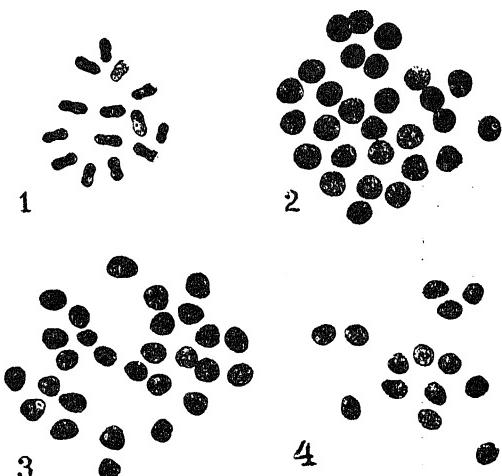
B. K. KARIBASAPPA.

1. Moringa, T., *Jap. J. Bot.*, 1935, **7**, 207.
2. Ramanujam, S., *J. Genet.*, 1937, **35**, 183.
3. Randolph, L. F., *Amer. Iris. Soc. Bull.*, 1945, **97**, 33.

CHROMOSOME NUMBERS IN THE GENUS CORCHORUS

Of the eight species of *Corchorus* reported from Indo-Pakistan sub-continent, the chromosome numbers of seven species are known and reported to be $2n = 14^{1-7}$. The chromosome number of a recently reported species was found to be also $2n = 14^8$. Chromosome examination of some exotic species revealed the presence of a tetraploid species, viz., *C. siliquosus*, L. from Jamaica.⁷ The present study was undertaken to find out the chromosome numbers of some more species and confirm the previous finding in respect of chromosome number of two species, e.g., *C. siliquosus*, L. and *C. tridens*, L. from root-tips. The somatic chromosome numbers of five species, two from Australia, namely, *C. walcottii*, F.v.M. and *C. elachocarpus*, F.v.M., one each from South Africa, Jamaica and Poland, namely, *asplenifolius* Burch Trav., *C. hirsutus*, L. and *C. hirtus*, L. respectively were determined and of these *C. hirtus* turned out to be a tetraploid having $2n = 28$ (Fig. 2) and the remaining four showed the diploid chromosome number, i.e., 14 (Fig. 1). The previous chromosome report was also confirmed (Figs. 3-4). Root-tips were collected from germinating seedlings grown

in Petri-dishes and chromosomes were stained in leucobasic fuchsin after prefixation in para-dichlorobenzene for 2 hours.



Figs. 1-4. Somatic chromosomes from root-tip cells of:
Fig. 1. *Corchorus walcottii* ($2n=14$). Fig. 2. *C. hirtus* ($2n=28$). Fig. 3. *C. siliquosus* ($2n=28$). Fig. 4. *C. tridens* ($2n=14$) ($\times 1,625$).

Our thanks are due to Mr. W. Hartley of C.S.I.R.O., Australia, Mr. C. R. Proctor, Institute of Jamaica, Miss E. R. Roux, University of Witwatersrand, Johannesburg, for their providing us the seeds of the various *Corchorus* species used in the present investigation.

Dept. of Botany, AHMAD SHAMSUL ISLAM.
Univ. of Sind, FEROZA QAIYUM.
April 24, 1961.

1. Banerji, I., *Jour. Ind. Bot. Soc.*, 1932, **11**, 82.
2. Bhaduri, P. N. and Chakravarty, A. K., *Sci. and Cult.*, 1948, **14**, 212.
3. Nakajima, G., *Jap. Jour. Genet.*, 1936, **12**, 211.
4. Nandi, H. K., *Nature*, 1937, **140**, 973.
5. Ganguly, J. K., *Sci. and Cult.*, 1945-46, **11**, 272.
6. Sarma, M. S. and Datta, R. M., *Ibid.*, 1953, **19**, 202.
7. Rao, N. S. and Datta, R. M., *Nature*, 1953, **171**, 754.
8. Islam, A. S. and Kadir, Z. B., *Biologia*, 1960, **6**, 169.

SPHAEROTHECA ON TWO MEMBERS OF EUPHORBIACEAE FROM HYDERABAD (INDIA)

THE members of Erysiphaceæ¹ are rather rare in hotter parts of the world when compared to their occurrence in temperate regions. In hotter parts of India powdery mildews are chiefly known to occur in the asexual stage (Oidium) alone. But occasional cold spells might induce

them for perithecial production. A thorough search of the powdery mildewed plants is likely to reveal more perfect stages which were hitherto not known to occur.

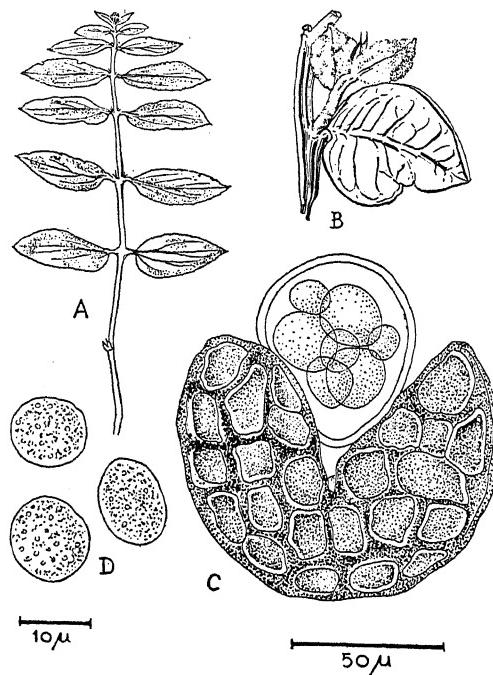


FIG. 1. A. Infected plant of *Euphorbia hirta*. B. Infected plant of *Pedilanthes tithymaloides*. C. Cleistothecium with a single ascus. D. Ascospores.

In this note, perithecial stage of a fungus which was discovered on *Euphorbia hirta*, L. and *Pedilanthes tithymaloides*, Poit. respectively is described. On examination the perithecial stage was found to belong to the genus *Sphaerotheca* which is reported for the first time. In an earlier paper² the 'Oidium' stage was recorded on the above-mentioned hosts.

Sphaerotheca euphorbiae (CAST.) SALMON

Fruiting eiphyllous, abundant, mature perithecia dark-brown, spherical to globoid, 40·8–102·0 μ in diameter, appendages flexuous, pale-brown and narrower towards the apex, 2–3 septate. A single, large, oval to globose ascus, subhyaline, apedicellate, with a basal papilla, 30·0–67·5 × 22·5–52·5 μ. Ascospores, 8 hyaline (golden-yellow), 1-celled, oval to elliptic, with granular contents and oil globules, and in various stages of development, 12·0–21·0 μ in diameter.

On the living leaves of *Euphorbia hirta*, L. and *Pedilanthes tithymaloides*, Poit. 21–12–1960, P. N. Rao, Secunderabad, O.U.B. Herb. 'Hy' No. 142, 143.

Note:—Fruiting on *Pedilanthes tithymaloides* is hypophyllous, perithecia measure 81·6–136·0 μ in diameter, asci 47·6–85·0 × 34·0–57·8 μ and ascospores 13·5–18·0 μ.

My grateful thanks are due to Dr. M. A. Salam, Head of the Department of Botany, for his encouragement.

Mycology and Plant Pathology Sec., P. N. RAO, Botany Department, Csmania University, Hyderabad-7 (A.P.), June 22, 1961.

1. Butler, E. J. and Bisby, G. R., *The Fungi of India*, 1931.
2. Salam, M. A. and Rao, P. N., *Indian Phytopath.*, 1958, 11, 126.
3. Saccardo, P. A., *Syll. Fung.*, 1899, 14, 462,

INHERITANCE OF HAIRY CHARACTER ON PODS IN BLACK GRAM (*PHASEOLUS MUNGO* L.)

STUDIES of inheritance of character have been widely conducted in genus *Phaseolus*. Bose (1939) carried out flower and seedcoat studies in *Phaseolus aureus* (Roxb.). Singh and Mehta (1953) found that in *Phaseolus aureus* L. the difference in leaf type was due to one pair of gene. As given in the Report of Indian Council of Agricultural Research (1950–51) interspecific crosses were also attempted between *P. radiatus* and *P. mungo* at Annamalai University and the hybrids obtained as a result were found to possess characters of both the parents, viz., vigorous growth, luxuriant leaves and high seed yield. Sen and Ghosh (1959) studied various characters in green gram.

In *P. mungo* the authors came across distinct types which had hairy as well as non-hairy pods. Crosses were made to study the inheritance of hairy pod character and it has been found that 'non-hairy' is simple recessive to hairy. The *F*₁ generation had entirely hairy pods. In *F*₂ the segregation was in the ratio of three hairy against one non-hairy as seen from Table I.

TABLE I
Segregation ratio in *F*₂ generation

Characters	Observed population	Expected population	d	d_2	$X^2 = \frac{d^2}{e}$	P. value (3:1)
Hairy	573	571·5	+1·5	2·25	{ 2·25	.80 to
Non-hairy	189	190·5	-1·5	2·25	{ 571·5	.90
					= 190·5	
	762	762	..	..		.016

In F_3 generation 234 hairy and 79 non-hairy were obtained which clearly confirmed the finding of F_2 generation.

Section of the Economic Botanist, G. N. PATHAK.
(Oilseeds) to Govt., U.P., K. P. SINGH.
Kanpur, June 8, 1961.

1. Bose, R. D., *Ind. J. Agric. Sci.*, 1939, 9, 575.
2. *Annual Report of Indian Council of Agricultural Research*, 1950-51, pp. 170.
3. Singh, D. and Mehta, T. R., *Curr. Sci.*, 1953, 22, 348.
4. Sen, N. K. and Ghosh, A. K., *Ind. Jour. of Pl. Breeding*, 1959, 19 (2), 210.

REARING OF MORE THAN ONE GENERATION OF UNIVOLTINE SILKWORMS

DUE to extremes of climatic conditions prevalent in the Punjab, Himachal, Jammu and Kashmir, the multivoltine races of silkworm cannot be reared successfully. The univoltine races commonly reared in this region undergo a long duration of egg diapause with the result that only one crop of silk can be procured although climatic conditions during a greater part of the year are favourable for rearing more than one generation particularly in the lower Himalayan region where silkworm food, the mulberry tree, can be grown in abundance. It was, therefore, felt that if the diapause of univoltine eggs was terminated artificially and the larvæ obtained were reared successfully more than one crop of silk could be obtained in a year. In the monsoon season when natural mortality among the larvæ was likely to be high and in the winter, when rearing was not possible without heating the culture rooms, the eggs could be allowed to remain in natural diapause. To that end experiments were conducted in the laboratory and effort was made to rear more than one generation of univoltine silkworms.

Over-wintered eggs of the univoltine race, Cevenne Jaune, No. 45, were procured from the Department of Industries, Punjab, and were hatched at $25 (\pm 0.5)^\circ\text{C}$. The larvæ were reared at that temperature as a normal spring brood. In the adult stage they laid eggs which were in diapause. In order to terminate diapause (Henneguy, 1904; Kogure, 1933) the procedure given was adopted: eggs were kept at 25°C . for 24 hours and then soaked in 2% formaline solution which ensured better fixation on the cardboard pieces on which those were laid; eggs were dipped in 15% hydrochloric acid (Sp. gr. 1.075) at 46°C . for 5 minutes, washed in water and were kept at 25°C . for incubation; the eggs hatched within 12 days.

The larvæ were reared at 25°C . They completed development in 32 days (25.9 for the first brood) and spun cocoons successfully. On emergence the moths laid eggs which were also in diapause. Those eggs were again treated in the same manner as mentioned above. The third brood larvæ also spun cocoons successfully. The moths on emergence laid eggs but further rearing was discontinued as the monsoons set in.

All the three broods were reared on leaves of *Morus alba* seedling variety. The average weight of larvæ and the silk shell produced by them were recorded for comparison between the three broods and those of the multivoltine races reared in Mysore by Sharada and Bhat (1956).

The larval weight of the 1st, 2nd and 3rd brood larvæ was 4.39, 3.46, 3.23 gm. and the silk produced was found to be 346.4, 193.0, 183.9 mg. respectively. Larvæ of the multivoltine race reared in Mysore under similar conditions attained 2.16 gm. body weight and produced 138.2 mg. of silk (Sharada and Bhat, 1956) which was significantly lower than that secreted by any of the three broods of the univoltine race including the 2nd and the 3rd brood larvæ hatched from eggs whose diapause was terminated by chemical treatment. It may be noted, however, that within the univoltine race silk yield of the 2nd and the 3rd brood was not as high as that of the 1st brood which apparently was associated with artificial termination of diapause.

The results indicate that rearing of more than one generation of the univoltine race of silkworm in the Punjab, Himachal, Jammu and Kashmir is possible and that the findings if tried in the field will have a great practical utility.

Govt. Agric. College and
Research Institute,
Ludhiana, May 29, 1961.

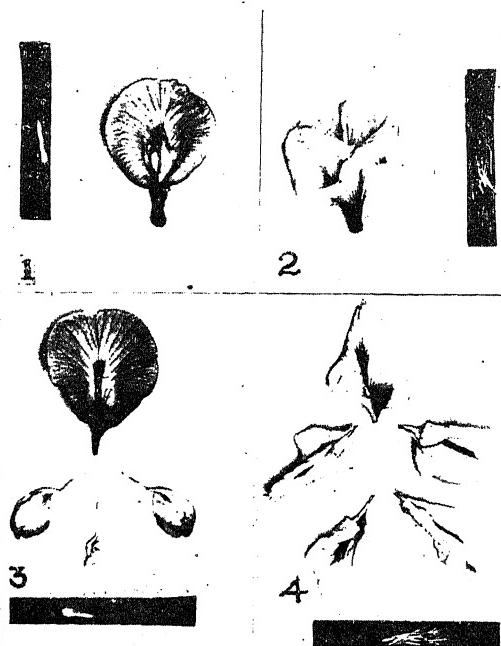
A. S. ATWAL.
A. N. VERMA.

1. Henneguy, L. F., *Les. Insects*, Paris, 1904.
2. Kogure, M., *J. Dep. Agric.*, Kyushu Univ., 1933, 4, 1.
3. Sharada, (Miss) K. and Bhat, J. V., *J. Ind. Inst. Sci.*, 1956, 38, 136.

BREAKDOWN OF THE PAPILIONACEOUS STRUCTURE IN THE DOUBLE FLOWERS OF *CLITORIA TERNATEA* L. AND ITS INHERITANCE

Clitoria ternatea L. commonly known as the butterfly pea or mussel shell creeper is a perennial ornamental plant conspicuous for its large papilionaceous flowers. According to Pal (1960) there are varieties with deep indigo-blue, light purple and white flowers, and variation in

flower-shape is provided by the occurrence of single and double forms. The double flowers are conspicuous for their non-papilionaceous nature, the five petals being more or less of equal size and shape, and the 10 free stamens. In their floral structure they resemble the pattern of the subfamily Cæsalpinoideæ more than that of the subfamily Papilionatæ to which the *Clitoria* belongs (Figs. 1-4).



FIGS. 1-4

Figs. 1-2. Blue single and hyacinth tinge double flowers of *Clitoria* and nature of their stamens. Their different petals are shown in Figs. 3 and 4.

To study the genetic basis of the difference between the single and the double flower types, a variety with blue (ultramarine blue) single flower was crossed with another with hyacinth tinge double flower (Colour Chart of Maerz and Paul, 1950). The hybrid had blue double flowers with large equal sized petals and 10 free stamens indicating the dominance of the double type. In the F_2 generation, four types of plants with (i) blue double; (ii) hyacinth tinge double; (iii) blue single, and (iv) hyacinth tinge single appeared. The frequency of double : single type flowers was in the ratio of 202 : 76 ; χ^2 (3 : 1) = 0.8105 ; $P = 0.50 - 0.30$, showing monogenic dominance of the double flower over the single

type. All the double flower had free stamens and the single flowers diadelphous 9 + 1 stamens.

In another cross between a white single closed flowered variety, where the standard petal was partially constricted towards the lower part, with a blue double variety—the hybrid had blue double flowers with free stamens. In the F_2 generation six types of flowers appeared and there too the frequency of double to single types was 102 : 20 ; χ^2 (3 : 1) = 0.5727 ; $P = 0.50 - 0.30$, showing monogenic dominance of the double type. This cross gave a beautiful large hyacinth coloured double flower type, which should find a place in the gardens.

The observations indicate that a mutation of a single gene has more or less broken down the papilionaceous nature of the *Clitoria* flower. As the single type is the predominant one and the wild *Clitorias* have single flowers, it is reasonable to assume that the double type originated through a dominant gene mutation. The change is comparable to that in the *radialis* mutant of *Antirrhinum majus* (Baur, 1924), where the mutant produced flowers with radial symmetry. The *radialis* mutant like most of the "large" mutations (macro-mutation) with drastic changes did not set seed naturally. But several examples are known, where even with conspicuous changes in flowers they are, nevertheless, fertile. The double flowered *Clitorias* produce a good number of fruits and seeds and being perennial in habit have the potentiality of surviving in nature.

Whatever may be the significance of such large mutations in the origin of species, genera and families, the double flowered *Clitoria* is an interesting example of the changes a single gene mutation may bring into the organs so vital in taxonomic classification, at the same time maintaining the viability and fertility of the plant.

Applied Botany Section,
Indian Institute of

NIRAD K. SEN.
R. KRISHNAN.

Technology,
Kharagpur (India),
June 26, 1961.

1. Baur, E., "Untersuchungen über das Wesen, die Entstehung, und die Vererbung von Rassenunterscheiden bei *Antirrhinum majus*," *Bibliotheca Genetica*, 1924, 4, 1.
2. Maerz, A. and Paul, M. R., *A Dictionary of Colour*, McGraw-Hill Book Co., New York, 1950.
3. Pal, B. P., *Beautiful Climbers of India*, Indian Council of Agricultural Research, New Delhi, 1960.

REVIEWS

Solution of Equations and Systems of Equations—Pure and Applied Mathematics. (*A Series of Monographs and Text-books*). By A. M. Ostrowski. (Academic Press, New York and London; India: Asia Pub. House, Bombay-1), 1960. Pp. ix + 202. Price \$ 6.80.

This monograph deals apparently with simple questions: Interpolation formulas, study of the roots of an algebraic equation, method of false position, various methods of iteration, linear difference equations and convergent product of matrices. Yet not only is the treatment extremely original; as the author writes in his preface, a great deal of unpublished material will be found throughout the book. At first sight one may be surprised to find in a series of texts meant for mature students of Mathematics a little volume of 200 pages devoted to questions which, most of them, can easily be grasped by a good student of the degree course. But a leading Mathematician like Professor Ostrowski was certainly well inspired to publish lecture notes intended primarily for the undergraduate level of universities in U.S.A. Not only students will find the study of them extremely interesting; lecturers themselves will, without any exception, derive considerable profit from their perusal. They will also appreciate a number of numerical exercises completely solved. It is not possible to analyse, in a short review, a book so rich in results. Suffice it to say that there is not one of the 18 chapters and of the 11 appendices which will not be found original. All contain some new point of view and all will inspire those teaching such subjects. Naturally one could not but expect from Professor Ostrowski admirable clarity of exposition and this in spite of concision. Such a monograph should be carefully studied by all those who wish so rightly to modernize the syllabuses of the degree, as well as of the post-graduate, course.

C. RACINE.

Advances in Space Science, Vol. 2. Edited by Frederick I. Ordway, III. (Academic Press, New York and London), 1960. Pp. xiii + 450. Price \$ 13.00.

Ever since the first sputnik was made to orbit around the earth, space science has made significant strides and is moving at present with a fast and an accelerated pace. Considerations of national prestige, the military applications of

rockets and the imagination that space travel evokes in the popular mind are some factors that have been responsible for the quick progress in this field, and these have rendered huge governmental grants to flow into space research organisations. A book that brings in the recent advances in space science will satisfy a timely need and the volume under review will therefore be welcomed by all scientists and space technologists.

The present volume comprises of review articles on important aspects of space science such as space physics, tracking, materials, electrical propulsion systems and attitude control, by well-recognised authorities in these fields. The first chapter of the book deals with space physics which the author defines as "a marriage of geophysics and astrophysics to rocket technology". Techniques and instruments devised to explore the nature of the earth's magnetic field, interplanetary and planetary fields; radiations from the sun and space; lunar, planetary and stellar features; interplanetary plasma; and micrometeorites are considered in detail and data are provided that reflect Pioneer space and Explorer artificial satellite experience.

The tracking of satellites and space vehicles is the subject of the second chapter which examines both the basic scientific and technological purposes of tracking and the methods actually being employed. While the chapter is primarily concerned with artificial satellite tracking, attention is also accorded to the optical tracking of lunar and planetary probes. Chapter III entitled "Materials in space" deals with the materials to which a space vehicle is exposed to, like the gases beyond the atmosphere, high energy particles, meteoritic dust, electromagnetic radiation from the sun and stars, etc., and gives an extensive coverage of the materials that the designer should choose in order that the space vehicle might withstand the environment of outer space.

In separate chapters, two important approaches to electrical propulsion of space vehicles are examined, one concerned with plasma devices such as chemical rockets, nuclear rockets, natural plasma devices, etc., and the other with electrostatic (ion beam) systems. The problem of altitude control assumes great importance as satellites and spacecrafts become very complex and are required to perform ever more precise

investigation of geophysical and astrophysical phenomena. In the final chapter of the book the requirements for altitude control are first considered and these are followed by detailed analysis of altitude reference systems, torques acting on satellites and space vehicles and methods of controlling altitude.

In spite of security measure that prevent publication of all material relating the space research, the present volume contains valuable information on the scientific and technological aspects of space science. The printing and get-up of the book leave very little to be desired.

K. S. V.

The Chemistry of Heterocyclic Compounds, Vol. 15—Heterocyclic Systems with Bridgehead Nitrogen Atoms—Part I. By William L. Mosby. (Interscience Publishers, Inc., New York), 1961. Pp. 747. Price \$48.00 ; Subn. \$43.00.

Over a thousand ring systems with bridgehead nitrogen atoms are known, but the present volume is the first consolidated account of this most interesting field and it is a very valuable addition to the literature of organic chemistry. Both atom-bridged and valence bond-bridged systems containing nitrogen at a bridgehead are to be covered in two parts, and Part I deals with fused ring systems of the following types : (a) 3- and 4-membered rings fused to other ring systems ; (b) fused 5/5 ring systems ; (c) fused 5/6 ring systems with no extra hetero-atom. The literature has been surveyed systematically through Vol. 50 (1956) of *Chemical Abstracts*, and through the first half of 1958 of American and European journals ; some work published in other journals after 1954 or 1955, such as Tilak's extensive work on pyrrocolines (indolizines) obtained from chloranil and 2, 3-dichloro-1,4-naphthoquinone, has also been included. The occasional impression one gets is an elaboration of the Ring Index, but this is perhaps unavoidable in a comprehensive review written with the main object of providing a source of information on individual members of a very large class. The plan of the book excluded a generalized treatment of such heterocyclic systems in relation to the influence of the nitrogen atom on ring stability and reactivity, the use of physical properties in structure determination, and the mechanism of reactions. However, there is a critical assessment of the validity of structures assigned to compounds on the basis of inadequate evidence, and attention is drawn to numerous problems requiring further investigation.

There seems to be no point in writing two resonance structures (II or III in the lower half of p. 51) with the statement that "Neither is, of course, a true representative of this nucleus". Structure (III) in p. 57 does not violate Bredt's rule which applies only to structures containing atomic bridges. Many repetitions of formulæ and the inclusion of erroneous formulæ, immediately followed by the correct formulæ which have superseded them, could have been avoided. In other ways also, such as the omission of the physical properties of numerous derivatives and a much shorter treatment of Ciba Yellow G and other obsolete and valueless dyes, the book could have been made available at a considerably lower price. A ring index and a subject index will appear at the end of Part II, but the absence of an index in Part I is to be deplored ; since Parts I and II do not constitute a continuous story there should have been no difficulty in providing separate indices.

K. V.

Gas Chromatography. Edited by Henry T. Noebels, R. F. Wall and Nathaniel Brenner. (Academic Press Inc., New York and London), 1961. Pp. xvi + 463. Price \$16.00.

Originating as a suggestion in a paper on liquid-liquid chromatography by A. J. P. Martin, gas chromatography (g.c.) has grown phenomenally in about a decade, into a powerful analytical tool, in research and industry. The pattern of development has followed on the lines of other important and commercially useful techniques like infra-red and n.m.r. spectroscopy. The basic ideas originate in academic institutions, industry takes them up, reduces the instrumentation problems to a routine. This in turn makes it possible for a wider application of the technique in basic research itself.

The book under review is a collection of 34 original papers, presented at the second Symposium on Gas Chromatography held under the auspices of Analysis Instrumentation Division of Instrument Society of America, in June 1959. The possibility of extending the scope and versatility of g.c. has been engaging the attention of workers in this field. The papers described in the book are representative of the present trends of development. They cover a wide range, from improvements in design and performance of g.c. instruments and their components, to newer applications of the technique. The new developments include wider temperature range of operation of columns, i.e., up to 500° C., use of more efficient columns both of packed and capillary type having plate

efficiency of the order of 3/4 of a million theoretical plates. Temperature programming for quick and efficient separation of complex mixtures, and problems connected with use of large-scale columns for preparative separation and purification have also evoked considerable interest. A great deal of effort is directed towards development of more sensitive detectors mostly of the ionization type, and evaluation of their characteristics. Other advances are concerned with development of better types of recorders, integrators and read-out systems, automatic fraction collectors, use of techniques like back flushing, etc.

A few papers deal with application on g.c. to the solution of complex analytical problems like separation of *ortho* and *para* hydrogen, separation and identification of difficultly tractable isomeric mixtures, etc. There is a paper on the use of g.c. for automatic process control.

Two useful features of the book require mention. There is an exhaustive bibliography of over 1,500 references covering from end of 1957 to June 1960. There are also tables of retention values of sample types for some standards columns. These tables will reduce the time and effort involved in the selection of columns for routine analysis.

A highly readable account of the discovery and initial development of gas chromatography by A. T. James, an important collaborator of A. J. P. Martin in this work, is particularly noteworthy.

All the articles in the book are by experts, many of whom are in the forefront in the field of gas chromatography and have already made notable contribution of concepts and techniques. The book is a useful contribution to the field of gas chromatography. It will be valued by all workers engaged in development of g.c. instruments and techniques, and also by persons interested in applying them to complex problems in analysis.

M. V. BHATT.

Annual Reports on the Progress of Chemistry for 1959. (The Chemical Society, Burlington House, London, W. 1), 1960. Pp. vi + 476. Price £ 2.

Every chemist knows the value of this annual publication issued by the Chemical Society. The present volume (LVI) follows the pattern of the recent previous volumes in this series, and gives the characteristically compact and masterly survey of the progress in almost every branch of chemical research during the year 1959.

Naturally, Organic Chemistry takes up a major share, nearly a third of the volume, and

among the topics reviewed in the theoretical section are the chemistry of carbanions and carbenes, in which researches during the year have yielded valuable stereochemical information. Progress in hydroboronation, which has excited wide interest, has been included. The review also contains recent developments in the chemistry of nitrogen-containing derivatives.

In the General and Physical Chemistry section among the topics chosen are Radiation Chemistry, Raman Spectroscopy and Nuclear Magnetic Resonance. In the Inorganic Chemistry section, following the earlier Reports general coverage of work published in 1959, rather than a series of reviews, has been attempted.

The section on Biological Chemistry starts with a review of chemistry of Bone and Tooth minerals. Other topics dealt with are Metabolism of β -carotene; Chemistry of Muscle Contraction and Relaxation; and New Amino-acids from Plants. In the Analytical Chemistry section, progress during the year in the fields of Polarography, Absorption and Emission Spectroscopy, and Radiochemical methods has been reviewed.

It is needless to mention that this volume should be in the possession of every library and research department. To enable individual chemists to own a copy the Chemical Society may explore the possibility of issuing paper-cover editions which may prove less expensive.

A. S. G.

Aerosols—Science and Technology. By H. R. Shepherd. (Interscience Publishers, New York and London), 1961. Pp. xiv + 548. Price \$ 22.50.

The spectacular advances in the Aerosol industry during the last two decades are apt to blur the fact that the Aerosol technology itself is still in its infancy. But, what vigorous and promising infancy! The mass of data that has poured in these few years is widely scattered in technical and trade journals, patent specifications, commercial bulletins, house organs and occasionally in popular publications. The time was ripe to garner this scattered harvest, sift and process the material and dish it out in a palatable form. This need is amply served by the book under review which gives an up-to-date and comprehensive picture of Aerosol technology and industry in the United States.

The sixteen chapters in the book are written by nineteen authors—each one of whom has made a significant contribution to the subject on which he writes. So, the book has the stamp of authority. The theory of Aerosols, a variety

of Aerosol products like cosmetics and fragrances, foods, pharmaceuticals, household and industrial Aerosols are handled. Aerosol containers, Aerosol designing and formulation, Aerosol coating compositions and the odour of Aerosols also receive attention. Most important are the two chapters on Valves and Propellants which form the "heart and soul", as it were, of Aerosol application. It is, therefore, all the more surprising that commercial filling techniques of Aerosols should have missed exposition.

A certain amount of overlapping and repetition is perhaps inevitable in such a compilation of contributions by eminent individuals. For example, the method of spray pattern determination is described on pages 145-59 and again on page 283. Similarly, the overrun of foam formulations is fully described on pages 28, 271 and 288 but is repeated on page 418. The Sizzal-spray illustrations on pages 186 and 410 look alike. The statistical data presented relate to the U.S. only. These minor blemishes do not however seriously detract from the worth of this book which is helpful to those engaged in Aerosol technology and industry.

The book is neatly printed, smartly finished and enriched with a number of good photographs. It is to be hoped that its price would not restrict its use in India—for, it is a valuable book.

M. N. SUBBA RAO.

Descriptive Palaeoclimatology. (A collection of papers.) Edited by A. E. M. Nairn. (Interscience Publishers, New York and London), 1961. Pp. ix + 380. Price \$ 11.00.

This is a product of the current fashion, a volume containing fourteen papers dealing with various aspects of Palaeoclimates, each contributed by different authors. The first two, by A. E. M. Nairn and H. H. Lamb respectively, are introductory and deal with the scope and principles of climatology. The next three are on Desert Sandstones (N. D. Opdyke), Evaporites (Robert Green) and Red Beds (F. B. Van Houten) and their significance in understanding climate. A chapter on the former cold climates (possible ice ages) by R. F. Flint follows. Nairn and N. Thorley deal with some geophysical aspects such as the use of oxygen isotope in determining the temperatures in marine basins in which certain molluscs lived and the connection between palaeo-magnetism and climates. The next three papers deal with organisms as possible indicators of climatic conditions—Vertebrates by A. S. Romer, Invertebrates by G. Y. Craig and Plants by R. Karausel. The last

four chapters are regional studies of certain major geographic regions—Europe and North America by M. Schwarzbach, the Far East by T. Kobayashi and T. Shikama, Pre-Tertiary Gondwanaland by Lester King, and Tertiary Gondwanaland by E. D. Gill.

In a work of this nature, there would inevitably be some unevenness of treatment, though this is compensated by the fact that each chapter is written by one well versed in the particular aspect. The data available in certain directions are still meagre, for instance in palaeo-magnetic and palaeo-wind measurements and generalisations from these data may lead to questionable deductions if not controlled by other evidences. On the other hand, the vast amount of factual data on the distribution of animals and plants and their significance could not be adequately dealt with in short papers owing to limitations of space, and have therefore been summarised.

In spite of these limitations, the coverage of the topics is excellent and authoritative and the volume gives a good review of the present status of our knowledge of palaeoclimates. One wishes however that the volume could have been larger so as to convey more information to the inquisitive reader. The volume is provided with detailed author and subject indexes which makes it easy to locate the information needed. The printing is exceptionally legible and clear and the get-up excellent. Readers from the less prosperous countries would wish that the cost (presumably around 10 dollars) could have been less if the book had been printed on less heavy paper with less sumptuous binding. The book should be read by all geologists and geophysicists interested in historical geology, palaeoclimatology, continental drift and related aspects.

M. S. K.

Swim-bladder Structure of Deep-Sea Fishes in Relation to their Systematics and Biology. By N. B. Marshall. "Discovery" Rep., 31: 1-122. Issued by the National Institute of Oceanography. (The University Press, Cambridge.) Price 55 sh. net.

This report by N. B. Marshall of the British Museum (who has considerably contributed to our knowledge of the swim-bladder of fishes as also to biology of deep-sea fishes in several publications) is based on the study of about 90 species of bathypelagic teleosts collected by the "Discovery". Contrary to the view held by some authorities that the swim-bladder or air-bladder could not function in the deep-sea environment owing to high hydrostatic pressure, and therefore,

was absent in them, it has been shown that this organ is commonly present in a number of major groups (Gonostomatidae, Sternopychidae, Myctophidae and Melamphaidae) and that these and other fishes also possess highly developed gas-producing structures. It has been brought to light that this organ has a distinctive design in the Stomiatoidea, deep-sea Salmonoidea, Myctophidae and Anoplogastridae and within each group variations occur. Certain features like the form of the gas-gland and its position relative to the resorbent area and perhaps also the circulatory system could be used as diagnostic features, e.g., in certain genera of Stomiatoidea. These structures and variations are described for each of the species of fish dealt with. The structures of the swim-bladder and its relationship to systematics have been reviewed for the several orders and families represented. The development of the closed swim-bladder and the evolution of bathypelagic fishes are discussed. It is shown for a number of species that in the larval phase the swim-bladder contains gas but the organ regresses (Miripinnati, certain Stomiatidae, few Myctophidae and Melamphaidae) and in some becomes infested with fat after metamorphosis to the adult form. In certain others the organ is completely absent (e.g., many Stomiatoids, Alepocephalidae, etc.). After considering the structure of the swim-bladder wall, the author discusses the functional, morphological and biological aspects as well as relationship of the organ to vertical distribution and vertical migration in the light of his own researches and earlier observations.

Space limits further ingestion into many details embodied in this account, considerable bulk of which is original. Suffice it to say that the account, an outstanding contribution to our knowledge of these denizens of the deep, is well presented and profusely illustrated, and would be welcomed by all interested in the biology of fishes.

R. SUBRAHMANYAN.

Microbial Reaction to Environment. Edited by G. G. Meynell and H. Gooder. (Cambridge University Press, London, N.W. 1), 1961. Pp. ix + 416. Price 42 sh.

This volume records the papers presented in London at the Eleventh Symposium of the Society for General Microbiology in 1961. As in the previous volumes, a number of interesting topics have been discussed by microbiologists who have distinguished themselves in different aspects of microbial reaction to environments.

There are fifteen contributions and they cover practically all the important aspects of microbial behaviour unaccompanied by alterations in their genetic structure. Most of them are well documented and include both historical and current information on the subject. Relatively newer developments in the subjects as (1) The effect of environment on the formation of bacterial flagella; (2) The influence of environment on the radio-sensitivity of micro-organisms; (3) Synchronization of division in cultures of *Saccharomyces cerevisiae* by control of the environment; (4) Environmental influence on genetic recombination in bacteria and their viruses; and (5) Antibiotic production as an expression of environment have also been discussed.

The book presents an up-to-date account of knowledge and would prove useful to both students and research workers as it contains topics which have not been reviewed recently and which offer possibility of much rewarding research.

J. V. B.

Cotton in India—A Monograph. Vol. IV. By S. M. Sikka, Arjan Singh, Avtar Singh, P. D. Gadkari, R. Balasubrahmanyam, N. K. Iyengar, K. Sawhney, V. K. Bedeker, G. B. Patel, P. S. Pandya, V. N. Paranjpe and N. S. Panigrahi. (Indian Central Cotton Committee, 14, Nicol Road, P.B. No. 1002, Bombay-1), 1961. Pp. 373. Price Rs. 30.

This volume, the last in the series, covers practically the same ground dealt with in the first three volumes, somewhat more elaborately with special reference to the six recognised cotton regions of the country. These regions are: (i) Northern *hirsutum*-*arboreum* region; (ii) Central *arboreum* region; (iii) Southern *hirsutum*-*arboreum* region; (iv) Central *herbaceum*-*arboreum*-*hirsutum* region; (v) Western *herbaceum* region and (vi) Eastern region. Full information is given region-wise on soil and climate, statistics of area and production, cultivation practices, results of agronomic investigations, important pests and diseases and recognized control measures, progress of breeding work, description of improved varieties and their coverage. Information is also provided on seed multiplication work, cotton legislation, marketing and economics of cotton production with special reference to each region and even individual States comprising each region. Except that the present volume brings together all information regarding cotton growing in different parts of India separately, much of it could have been incorporated in the chapters dealing with

the subject in the earlier volumes. For example, information on Physiology of the cotton plant could well have gone into Chapter I and similarly information on diseases and pests into Chapters III and IV respectively of Volume II.

The volume provides critical data on the relative importance of the different regions with regard to total production as well as production according to quality. In giving lint lengths which determine quality, the production figures of American and desi cottons are however lumped together instead of separately. Of the regions the eastern region is of very minor importance at present, but the new areas brought under irrigation in Orissa and West Bengal offer great potentialities for increasing production. The volume is very well illustrated with a number of charts and photographs of typical plants of the different improved varieties of cotton now under cultivation. For one not much interested in the fundamentals, the present volume by itself provides all information on Cotton in India.

K. R.

Advances in Morphogenesis, Vol. 1. Edited by M. Abercrombie and Jean Brachet. (Academic Press, New York and London), 1961. Pp. xiii + 445.

The book is the first volume in this new Series whose main object is to link up the various branches of biology dealing with development. It comprises 9 chapters, each written by an expert in his field of study.

In Chapter 1, Dr. Tuneo Yamada discusses the problem of organizer (as distinct from agent or factor) and opines that an essential understanding of its action will be obtained only when the first biochemical or biophysical changes evoked by the inducing agent within the cell are known.

The Ascidian egg is significant in that it can remain in unfertilized condition in the oviduct for a long time without undergoing any divisions and that its mode of development is intermediate between the mosaic type and the regulative type. These peculiarities have been thoroughly exploited by Dr. G. Reverberi who has analysed the egg constituents and discussed in Chapter 2 their significance in morphogenesis. The next two chapters are devoted to regeneration of appendages and tissue and are interesting reading even to the non-expert.

In plants, unlike animals, the capacity to produce the plant body does not reside in the zygote alone, it may well persist in almost any living cell of the entire plant body. For this reason

Prof. F. C. Steward and Dr. H. Y. Mohan Ram have reviewed the relevant work on plant cells with a view to understand factors determining cell growth in Chapter 5 that is the only chapter contributed by botanists. Herein it is concluded that once cells are endowed by their origin, with that deep-seated or 'built-in' capacity to grow, the manner in which this is expressed is controlled by regulatory substances within certain limits imposed by genetic machinery.

In the next chapter Dr. C. E. Wilde Jr. discusses the differentiation of vertebrate pigment cells that have long been favourable material for investigation of cell behaviour and the processes of migration, distribution and differentiation. Chapters 7 and 8 deal with the morphogenesis of vertebrate limb and eye respectively and in the last chapter Dr. Ch. Devillers discusses the structure and dynamic aspects of the development of the teleostean egg.

Every chapter begins with a repetition of its contents and is followed by a detailed and up-to-date bibliography that is not necessarily complete. At the end there is the Author Index and Subject Index. The book has a get-up of high standard and the reproduction of figures too, though few, is good.

I wish the editors had invited a few more botanical contributions for the simple reason that the problem of morphogenesis in plants is comparatively simple (?), and the information gained there may be useful in the solution of complex problems in animals.

Most chapters are reviews that deal primarily with the work of the contributors and as such they are intended for workers in their respective fields. But it is hoped that the information so gathered will be reviewed subsequently for much wider use. As it is, the book is a standard reference work on this vital and ever-increasing subject of morphogenesis.

V. PURI.

Information Retrieval and Machine Translation. Part 2. Edited by Kent (Allen). (*Advances in Documentation and Library Science, 3-2*). (Interscience Publishers, New York and London), 1961. 23 × 15 cm. Pp. 12 + 606. Price \$ 25.00.

This is the second part of the transactions of the International Conference for Standards on a Common Language for Machine Searching and Translation, sponsored by Western Reserve University and Rand Development Corporation and held in Cleveland, Ohio, from 6 to 12th September 1959.

This Conference is a symptom of the crisis developing in the world of research. Research has now become a social necessity as a result of population pressure exceeding the capacity of natural and near-natural commodities. Research cannot any longer be left solely to the prompting of an inner urge in exceptional men of genius appearing occasionally. On the other hand, the work of many a man of genius has to be followed up by a world-wide team of intellectuals of all grades, so as to exploit it fully for social benefit. Therefore, the annual research output runs to millions of micro documents appearing as articles in periodicals. This cascade creates the new problem of avoiding unintended and unnecessary repetition of the same item of investigation by different teams of workers. Its avoidance calls for organising the research output in such a way that each item is brought to the notice of the concerned research teams promptly, pin-pointedly, and exhaustively, so that it can be carried to a further stage of research. This new responsibility falls to the share of the library profession and it is called documentation.

The efficiency of documentation depends on the design of a system of expressive, co-extensive class-numbers to represent each micro thought uniquely. In certain circumstances, speed of the retrieval of the documents relevant to a particular problem on hand needs the use of machinery. In its turn, the machinery calls for class-numbers to be translated into machine code symbols. Thus, the library profession is now engaged in the development of two artificial languages—the classificatory language and the machine language. The object of the Conference was to explore the possibility of designing the two languages in relation to each other so as to avoid the wastage involved in transitioning from the one to the other. This is the first international attempt of the kind. It cleared the ground for future work.

The Conference was attended by about 200 persons from ten countries. India was represented by one delegate. This part includes 39 out of the 61 papers presented at the Conference. Five of these are on design of machinery for information retrieval; 21 concern themselves with machine translation; and the remaining 13 overlap both these fields. Two of the 39 papers are contributions from India. They are entitled *Natural, Classificatory, and Machine Languages, and Classification and Retrieval* respectively.

The last 45 pages of the text contain the decision made for future action. An International

Continuing Committee was formed with B. C. Vickery (England) as Chairman, Allen Kent (U.S.A.) as Secretary, and representatives from each of the ten participating countries. One of the three Vice-Presidents was selected from India. Four sub-committees were set up to stimulate work on each of the following subjects :—

1. Standardisation of terminology and nomenclature with S. R. Ranganathan (India) as Chairman;
2. Exchange of materials and information, with S. N. Alexander (U.S.A.) as Chairman;
3. Exchange of personnel, with Chairman to be named by U.S.S.R.;
4. Research with E. de Grollier (France) as Chairman.

S. R. RANGANATHAN.

Books Received

From : Interscience Publishers, 250, Fifth Avenue, New York-1 :

Pharmaceutical Analysis. Edited by T. Higuchi and Einar Brochmann-Hanssen, 1961. Pp. ix + 854. Price \$ 28.50.

Metalurgical Society Conferences (Vol. 10). *Columbium Metallurgy*. Edited by D. L. Douglass and F. W. Kunz, 1961. Pp. xvi + 746. Price \$ 26.00.

Treatise of Analytical Chemistry. Part II. *Analytical Chemistry of the Elements* (Vol. 5). Edited by I. M. Kolthoff and Philia J. Elving, 1961. Pp. xxi + 409. Price \$ 13.75.

From : Academic Press, Inc., 111, Fifth Avenue, New York-3, N.Y.; India : Asia Publishing House, Bombay-1 :

The Quantum Mechanics of Many-Body Systems. By D. J. Touless, 1961. Pp. ix + 175. Price 45 sh.

Methods of Celestial Mechanics. By D. Brouwer and G. M. Clemence, 1961. Pp. xii + 598. Price \$ 15.50.

Fuel Element Fabrication with Special Emphasis on Cladding Materials, Vol. I. Pp. xi + 538. Price 100 sh.; Vol. II. Pp. xii + 384. Price 71 sh. 6 d.

From : Butterworth and Co., 88, Kingsway, London, W.C. 2 :

Progress in Organic Chemistry. Edited by J. W. Cook and W. Carruthers, 1961. Pp. viii + 172. Price 50 sh.

Diffusion and Heat Flow in Liquids. By H. J. V. Tyrrell, 1961. Pp. xii + 329. Price 65 sh.

Systematic Qualitative Analysis—An Introduction. By G. A. Morrison, 1961. Pp. ix + 198. Price 65 sh.

Cybernetics—Control and Communication in the Animal and the Machine (Second Edition). By N. Wiener. (The M.I.T. Press and John Wiley and Sons, New York-16, N.Y.), 1961. Pp. xvi + 212. Price \$ 6.50.

British Medical Bulletin—Human Genetics. (Vol. 17, No. 3). (The Medical Department, The British Council, 65, Davies Street, London, W. 1), September 1961. Pp. 177-264. Price 20 sh.

Dispersion Relations and the Abstract Approach to Field Theory. Edited by Lewis Klein.

(Gordon and Breach Science Pub., Inc., 150, Fifth Avenue, New York-11, N.Y.), 1961. Pp. x + 273. Price \$ 4.95.

Progress in Nuclear Energy—Reactors. (Vol. 2). Edited by H. R. McK. Hyder. (Pergamon Press, Headington Hill Hall, Oxford), 1961. Pp. vi + 557. Price £ 5-5 sh.

Agriculture Monograph 25—Atlas of Avian Hematology. By A. M. Lucas and C. Jamroz. (Regional Poultry Res. Lab., Animal Husbandry Research Division, East Lansing, Mich.), 1961. Pp. vi + 271. Price not given.

SCIENCE NOTES AND NEWS

Award of Research Degree

Osmania University has awarded the Ph.D. degree in Botany to Shri Pannuri Ramarao for his thesis entitled "Seasonal Variation, Distribution and Taxonomy of Micro-Fungi in Soils of Hyderabad".

Symposium on Plant Tissue and Organ Culture

A Symposium on Plant Tissue and Organ Culture organized jointly by the University of Delhi and UNESCO South Asia Science Co-operation Office, Delhi, will be held at the University of Delhi from December 22-29, 1961.

Tissue and organ culture promises to throw light on several problems of fundamental value concerning growth and metabolism, including physiology of fruit growth. It can also be exploited in overcoming the barriers to crossability, and induction of parthenogenesis and polyembryony. During the past 20 years work on these lines has been initiated in several laboratories in different parts of the world, and very useful results obtained even in preliminary trials. The Symposium will not only enable workers in South Asia to exchange views and discuss their problems with foreign experts, but will also help them in a correct appraisal of the work in progress in other countries.

Invitations have been extended and accepted by the following international experts on behalf of UNESCO : (1) Professor J. P. Nitsch, France ; (2) Professor J. Reinert, West Germany ; (3) Professor F. C. Steward, U.S.A. ; (4) Professor H. E. Street, U.K.

An Organizing Committee under the chairmanship of Professor P. Maheshwari, Professor of Botany, Delhi University, has been constituted.

Further information in connection with the Symposium can be obtained from : Mr. J. Swarbrick, Acting Director, UNESCO South Asia Science Co-operation Office, 100, Sundar Nagar, New Delhi (India).

Rotating-Wall Laboratory for Building Research

A rotating-wall laboratory for research into heat transfer through different types of walling material under varying conditions of exposure has been built for Britain's Department of Scientific and Industrial Research (DSIR) station at Garston, near Watford, southern England. A model of the laboratory, which can be rotated through a full circle, is to be shown at the Building Exhibition at Olympia, London, from November 15 to 29. The rotating wall of the laboratory should enable scientists to calculate space heating with greater accuracy than before.

Another model to be shown on the Ministry's stand is the DSIR's anechoic chamber and reverberant room. This chamber is thought to be the largest anechoic chamber in Europe. It is entirely without an echo, and is to be used, among other things, for research into transmission of sound from partition walls.—(British Information Service.)

Memoirs of the Indian Botanical Society

The Indian Botanical Society brings out in addition to its well-known quarterly the *Journal of the Indian Botanical Society* which is now running its 40th volume, special publications of great value giving a connected account of the latest developments in different branches of botanical research. Among these priced publications are the *Memoirs of the Indian Botanical Society* three of which have so far come out

under the editorship of Prof. T. S. Sadasivan. Memoir 1 (1958, pp. 159, Price Rs. 8.50) contains the papers presented at the three Symposia of the Botany Section of the Indian Science Congress in 1958. They are "Modern Trends in Plant Taxonomy"; "Physiology of Micro-organisms"; and "Floristic Studies in India".

Memoir 2 (1960, pp. 101, Price Rs. 7.50) contains the Papers contributed to the Symposia on "Tissue and Organ Culture of Plants", and "Carbohydrate Metabolism" of the 1959 Indian Science Congress.

The latest publication in this series, namely, Memoir 3 (1961, pp. 210, Price Rs. 14.50) pertain to the Symposia on "Distribution Pattern of Plants in India" and "Effect of Chemicals on Cell Division" of the 1959 ISC, and on "Dynamics of Soil Fungi" and "Recent Advances in Angiosperm Morphology" of the 1960 Congress. These symposia articles thus made available in compact volumes will be useful not only to the specialist research workers in the various fields of plant science, but also to teachers and students of the universities in India and elsewhere.

Structural Materials in Chemical Technology

"Werkstoffe in der chemischen Technik" is the title of Volume 39 of the series of *Dechema Monographs* which has just been published by the Verlag Chemie GmbH., Weinheim/Bergstrasse (286 pages, Price DM 24.80; to members DM 19.80). The present volume contains the text of 16 lectures which were presented at the Dechema Annual Meeting 1960. Each of the lectures is based on a different theme in the field of structural material techniques and particular value is attached to discussing applications in the most important problems. The subjects covered include the prevention of metallic corrosion, the prevention of boiler scale, the use of noble metals in the construction of plant, the properties of cladded materials, the use of acid and heat resisting substances as well as of plastics materials in Chemical Technology and in the control of quality of chemical plant. A discussion on structural materials for the building of rockets is of general interest.

Summaries of the individual lectures in English and French are included. A subject index completes the volume.

World Population Trends

The methods used by the United Nations Organization in preparing population statistics of the different countries are explained in the *UNO Demographic Yearbook 1960*. The year-book includes a table which shows the popula-

tions of each political area in every year since 1920. The total population of the world in 1959, is estimated as between 2,835 and 2,964 millions. Of this nearly one half, between 1,416 and 1,508 millions, is now concentrated in four countries China, India, U.S.S.R. and U.S. The other areas of the world have an estimated population between 1,431 and 1,476 millions. India's population is known within 11 millions, and that of USSR and US within 3 millions. The uncertainty about the population of China is the major factor in the range.

It is estimated that the rate of growth may lie between 1.5 and 2% per annum, resulting in a total annual increase of 44-55 millions.

Oxygen Intake by the Roots of Rice Plant

The physiology of the rice plant and its nutritional requirements pose a problem which needs thorough investigation. It is known that nearly all plants need oxygen in the soil in their root zone. Whereas the leaves of plants take in oxygen only at night—during the day in the presence of sunlight they absorb carbon-dioxide from the atmosphere—so far as the roots are concerned there is a continuous intake of oxygen from the soil. If the soil pores are blocked by flooding, oxygen from the atmosphere cannot get into the soil and the roots are starved of their oxygen supply. The question arises: how does the rice plant which is generally grown on marshy or flooded land—sometimes under several feet of water—cope with the situation? Further, flooding induces chemical changes in the soil some of which are known to be unsuitable for plant growth. But these do not seem to affect the rice plant. Rice seems to have peculiarly adapted itself to withstand a variety of unusual conditions.

Radio-isotopes offer an effective technique for the study of the metabolic mechanism in rice. Experiments with the help of radio-active carbon C-14, have led to some interesting results, although not yet conclusive, regarding the intake of oxygen by the roots of the rice plant. They suggest that rice has a mechanism whereby hydrogen peroxide is excreted from its roots. This hydrogen peroxide releases oxygen, thereby maintaining the oxygen supply in the neighbourhood of the roots.—(IAEA Bulletin).

Atlantic Undercurrent

Ever since a submerged equatorial flow—the Cromwell Current—was discovered in the Pacific a few years ago, oceanographers have been expecting to find an under-current in the Atlantic and possibly in the Indian Ocean as well.

Recently Arthur D. Voorhis of the Woods Hole Oceanographic Institution, during a cruise of the research vessel *Chain*, identified a subsurface current in the Atlantic Ocean. It appears to flow eastward along the equator at a depth of about 100 metres in a belt extending from 1°-2° south of the equator to 1°-2° north, very much like the Cromwell Current. The speed of the Atlantic current is estimated at 2 knots, as against a speed of 2½-3 knots for the Cromwell Current.

—(Scientific American, September, 1961).

Steroids as Ice Nucleators

Substances that are usually suggested as possible ice nuclei for cloud seeding are inorganic compounds of hexagonal structure with lattice parameters similar to those of ice. The discovery of a class of organic materials capable of acting as ice nuclei appears to be novel. R. B. Head of the C.S.I.R.O. Chemical Research Laboratories, Melbourne, finds that some steroids can as effectively nucleate ice as silver iodide.

In the investigation activities to nucleate ice were determined by means of a microscope cold stage into which slides carrying steroid particles could be inserted. Provision was made for the introduction of moist air. The particles under test thus acted as freezing nuclei.

The most active steroids found by Head were androsterolone, testosterone, 3 α -methylcholestan-3 β -ol, androsterone, pregnenolone, androstan-3, 17-dione, and cholesterol. It was found that droplets smaller than about 0.03 mm. diameter were usually inactive, and nucleation of all particles larger than 0.03 mm. was complete at — 7° C.

It is usual to associate nucleation with the similarity in spacing between the ice lattice and that of the nucleating substance. Although the exact crystal structures of many steroids are still unknown there are evidences to believe that the molecules in the majority of steroid structures are arranged in parallel stacks with head-to-tail packing. One surface of the stack would thus present a pattern of alternating hydroxy groups and sidechains. It is presumed

that nucleation takes place on this surface. It is also significant that the cross-sectional dimensions of the steroid molecule, viz., $5 \pm 1 \text{ \AA} \times 7 \pm 1 \text{ \AA}$ suggests a possible compatibility with the prism face of ice, $4.5 \text{ \AA} \times 7.35 \text{ \AA}$.

It is also found that the steroids most active in nucleation have keto or hydroxy groups at position 3, and many of them have keto groups at position 17, in addition. If it is assumed that the essential requirement for activity is a hydroxy or keto group at position 3, it is clear why no activity is shown by the steroid esters since esterification occurs at this position.—(Nature, 1961, 191, 1058.)

A New Hypothesis for the Origin of Lunar Domes

The problem of the origin of lunar domes is one which appears to lend itself most readily to solution by analogy with terrestrial features. To the number of hypotheses currently in vogue for the origin of the lunar domes J. W. Salisbury of the Air Force Cambridge Research Laboratories, Bedford, Mass., has added one more, namely, the mineral phase-change expansion hypothesis. This mechanism was first proposed by Hess for terrestrial domes and uplifts.

Hess presented evidence to show that the materials below the Mohorovicic discontinuity is peridotite and that, for a considerable depth beneath the Moho the temperature will be below 500° C. He then used the Bowen and Tuttle data on the $\text{MgO}-\text{SiO}_2-\text{H}_2\text{O}$ system to show that serpentinization of olivine would occur at temperatures of 500° C. or less, provided that water could be introduced into the system.

Olivine + Water \rightleftharpoons serpentine + heat.
The change from olivine to serpentine involves approximately a 25% increase in volume, which would be more than adequate to produce domical structures.

In order to have the same mechanism of uplift active in the moon we must assume peridotitic material to be present in temperature region below 500° C. with subsequent introduction of water vapour.—(Astrophys. Jour., 1961, 134, 126.)

796-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

PRINCIPLES OF NUCLEAR MAGNETISM*

SINCE the first successful detection of nuclear resonance signals in 1946, independently by Bloch *et al.* and Purcell *et al.*, Nuclear Magnetic Resonance or NMR spectroscopy has become an important tool of research in diverse fields, such as chemistry, metallurgy, geology and biology. The rate at which the application of this technique is developing is phenomenal. Besides its first and obvious application to the measurement of nuclear moments, currently it is the most successful method of obtaining precise information on the finer properties of matter in bulk. Structure of molecules, reaction rates and chemical equilibria, chemical bonding, crystal structures, internal motions in solids and liquids, electronic densities in metals, alloys and semiconductors, internal fields in ferromagnetic and antiferromagnetic substances, density of states in superconductors, properties of quantum liquids, are some of the topics where nuclear magnetic resonance experiments have so far provided specific and detailed information. This wealth of applications should not, however, obscure the fact that nuclear magnetism is in its own right one of the most fascinating domains of pure physics.

Following the original suggestion made by Pauli in 1924 to explain the hyperfine structure of spectral lines, it has been now well established that atomic nuclei possess in their ground state a non-zero spin angular momentum $I\hbar/2\pi$ (where I is an integer or half integer), and, collinear with it, a dipolar magnetic moment $\mu = \gamma I\hbar/2\pi$, where γ is the gyromagnetic ratio which is characteristic of the nucleus. The order of magnitude of these magnetic moments is between 10^{-3} and 10^{-4} Bohr magnetons. It is these moments that give rise to 'nuclear magnetism'.

Besides the difference in the order of magnitude between nuclear magnetism and electronic magnetism, there are other differences which are worth noting. Thus, of the three aspects of magnetism, namely, ferromagnetism, diamagnetism, and paramagnetism, only the last is of interest in nuclear magnetism. It will be noted that ferromagnetism may arise when kT , the product of Boltzmann constant and the temperature of the sample, becomes comparable to the couplings between the spins. The strong exchange coupling of electrostatic origin that gives rise to electronic ferromagnetism is absent

in nuclear magnetism, and further the magnetic coupling between nuclear spins is such that temperatures of the order of 10^{-7} K. would be required for a possible observation of nuclear ferromagnetism (or antiferromagnetism). Electronic diamagnetism arises from the Larmor precession of the electronic charges in an applied magnetic field. Such a case is not easy to visualise in nuclear magnetism, and at least in bulk matter it can reasonably be expected to be negligible. Thus we are left with paramagnetism only. Here too, unlike in the case of electronic paramagnetism where there is an appreciable contribution from the orbital motion of the electrons, nuclear paramagnetism is entirely due to the spins of the nuclei and that of orbital origin is of no significance in bulk matter. Again, because of the smallness of the nuclear paramagnetism static methods of measurement as in the case of electronic paramagnetism become too insensitive to bring out the finer points in this field of study. Although a static measurement of nuclear magnetic susceptibility had been made as early as 1937 by Lazarew and Schubnikow, on solid hydrogen at 2° K., nuclear magnetism would probably have remained a simple curiosity if much more sensitive methods using the principle of resonance had not been developed. Now, it may be said that this is the one branch of modern physics where there is very close connection between theory and experiment.

While there are many books on the subject dealing with the practical applications of nuclear magnetism and NMR spectroscopy, those that are devoted to the elucidation of the fundamental aspects of the subject from necessarily a theoretical point of view are indeed few. In this context a theoretical book bringing out the underlying principles of nuclear magnetism will be a most welcome addition to the literature on the subject. The book by Prof. Abragam gives a consistent description of the various aspects of nuclear magnetism on a unified basis. The outlook is mainly theoretical and the book is obviously intended for that category of readers who would like to delve deep into this fascinating field of study. As the author says in the Preface "What I had in mind was to attempt for nuclear magnetism what Van Vleck has done for the theory of electric and magnetic susceptibilities in a book which thirty years after its publication is still the book on the subject". The author's expectation is not wrong. The *Principles of Magnetism* will be a book of abiding value on the subject.

* *The Principles of Nuclear Magnetism.* By A. Abragam. (International Series of Monographs on Physics, Oxford at the Clarendon Press), 1961. Pp. xvi + 599. Price (in U.K. only) £ 4·4 s. net. Rs. 67·20.

COUMARIN AS THE STIMULATOR OF GROWTH OF ETIOLATED MAIZE STEM TISSUE

J. S. KNYPL AND A. P. DMITRUK

Department of Plant Physiology, University of Łódź, Łódź, ul. Narutowicza, 68, Poland

THAT coumarin (*o*-hydroxy-*cis*-cinnamic acid lactone) is a substance with a physiological activity has been known for a long time.¹ At first it has been generally regarded as an inhibitor of seeds germination²⁻⁴ and growth of seedlings, but later some evidence has been gathered that effects induced by this substance depending upon condition, plant genus, kind of tissue, its own concentration, etc.,—might be diverse, and there are well documented findings that coumarin can function as a naturally occurring plant growth regulator.

In 1938 Grace,⁵ based on results of his experiments, first concluded that coumarin probably plays a role of an auxin. Some years later Thimann and Bonner,⁶ and Gantzer⁷ reported that in certain concentrations coumarin acts synergistically with indole acetic acid (IAA), and finally Neumann,⁸ who examined effects of coumarin on the longitudinal elongation of sunflower hypocotyls and similar tissues of other plants, concluded that this substance should be regarded as an auxin,⁹ with the mode of action differing from that of IAA and, probably of gibberellin (GA) too.

The growth-promoting action of coumarin is very interesting and, in order to obtain some further evidence of the generality of this phenomenon, we have performed experiments with maize seedlings.

Maize seeds (*Zea mays*, var. Wir. 42), after 3 hours period of soaking in water, were grown in sterilized quartz sand at 26° C. in darkness except for occasional diffused daylight. Five days later, 10 mm. segments were cut from the stem, 5 mm. below the leaf node (the plants in this stage were 5 cm. long) and the sections were floated on distilled water for 2.5 hours, then divided into lots of 15, carefully dried on blotting paper and—after quickly weighing—were floated on surfaces of the test solutions poured into small petri dishes.

In the control sample, instead of coumarin, 10 ml. of distilled water were poured.

After 20 hours period of incubation under diffused fluorescent tube light at room temperature (+ 22.5° C.) the segments were taken out and their increase in weight were measured (preliminary experiments have shown that the increase in weight runs parallel to longitudinal elongation of sections).

From the results presented in Table I it is evident that coumarin significantly accelerates the growth (longitudinal elongation) of sections, and the level of this stimulation depends upon concentration of this substance. In solutions 250 and 500 p.p.m. increase in weight reaches about 255% of control value taken as 100%. The range of concentration of coumarin is optimal—more concentrated solutions produce inhibition and coumarin in 1,000 p.p.m. is toxic for the plant: the longitudinal extension of sections is stopped and at the end of incubation they are flexible, look brownish, and seem to be killed. It is necessary to say that in solution of 500 p.p.m. at the end of 20 hours incubation period the segments are too slightly flexible; additional experiments revealed that the growth rate of sections treated by coumarin is not constant with time—the growth rate reaches its maximum value within the first 4 hours and then it decreases (it was noted that in the first hours of treatment, the growth of sections floated on the surface of 500 p.p.m. coumarin solution was accelerated to about 450% of control, and slight stimulation was observed in 1,000 p.p.m., too).

In the literature there are some evidences supporting the idea that coumarin influences the water relation of plants.¹⁰⁻¹² Therefore, in addition to fresh weight we have also measured the dry weight of samples at the start and at the end of incubation. As in the test solutions there was no sugar or other nutritional compounds—it is clear that the increase in fresh weight of samples must be attributed to absorption of water only, and the dry matter of samples would be reduced as a result of CO₂ output in the respiration. The truth of this *a priori* supposition will be apparent from the following observations (see Table I):—In the sample treated with distilled water (control)—in the time of experiment the fresh weight of sections increases from the initial 100 mg. to the final 117 mg., and the percentage of dry matter calculated from the equation:

$$\frac{\text{dry matter}}{\text{fresh weight}} \times 100$$

falls from 5.97 to 5.06; in absolute values the dry matter changes from about 5.97 mg. to 5.93 mg. so that the net loss

TABLE I
Effect of coumarin in different concentrations on the growth of excised maize stem tissue through 20 hours period of incubation

Initial values	Concentrations of coumarin, in p.p.m.							
	0 Control	10	50	100	250	500	1000	
Fresh weight, mg. ..	100.0	117.1	120.5	121.5	128.2	136.7	137.0	117.0
Increase of fresh weight, in % ..		100	120	126	165	215	216	96
Dry matter, mg. ..	5.97	5.93	6.14	6.11	6.10	5.86	5.54	5.23
Change of dry matter, mg. ..		-0.04	+0.21	+0.18	+0.07	-0.11	-0.43	-0.74
Dry matter \times 100 fresh weight	5.97	5.06	5.10	5.03	4.76	4.29	4.05	4.44

All values are average of 6-8 repetitions.

of weight equals 0.04 mg. In the same time in solutions 10, 50 and 100 p.p.m. of coumarin dry matter increases by 0.21 mg., 0.18 mg., and 0.07 mg., respectively, and in more concentrated solutions it significantly decreases (see Table I).

Because the rise of fresh weight is accompanied by the decrease in dry matter, it might be concluded that stimulation of growth caused by coumarin is caused—partly at least—by acceleration of water absorption by sections. The increase in dry matter in solutions 10-100 p.p.m. is not clear; but the significant decrease of dry matter at 250 and 500 p.p.m. may be the result of simultaneous stimulation of respiratory activity of tested sections induced by coumarin and more rapid dissimilation of sugars on this way (results not yet published)—solution of 1,000 p.p.m. of coumarin probably additionally kills the tissue and this leads to diffusion of cellular components to the surrounding fluid.

In order to obtain some evidence concerning the mechanism of the growth-promoting activity of coumarin described we performed comparative experiments with indole acetic acid and gib-

berellin. While the details of these will be published elsewhere, here it is necessary only to say that our results are similar to those reported by Neumann⁹ for sunflower hypocotyls and it may be concluded that the nature of coumarin action in promoting the growth of excised maize stem sections differs from that of IAA and GA, but it is doubtful whether coumarin may be named an auxin.

1. Klebs, A., *Die Bedingungen der Fortpflanzung bei einigen Algen und Pflanzen*, Jena, 1890.
2. Sigmund, W., *Biochem Z.*, 1914, **62**, 339.
3. Kuhn, R., Jerckel, D., Moewus, F., Moller, E. F. und Lettre, H., *Naturwiss.*, 1943, **31**, 468.
4. Evenari, M., *Symp. Soc. Exp. Biol.*, 1957, No. 11, 21.
5. Grace, N. H., *Canad. J. Res.*, 1938, **16C**, 143.
6. Thimann, K. V. and Bonner, W. D., *Proc. U.S. Natl. Acad. Sci.*, 1949, **35**, 272.
7. Gantzer, E., *Planta*, 1960, **55**, 235.
8. Neumann, J., *Science*, 1959, **129**, 1675.
9. —, *Physiol. Plantarum*, 1960, **12**, 328.
10. Guttenberg, H. und Beythien, A., *Planta*, 1952, **40**, 36.
11. Blaum, K., *J. Exp. Botany*, 1960, **11**, 377.
12. Knypl, J. S., *Naturwiss.*, 1960, **47**, 524.

NUCLEI FOR RAIN FORMATION

INTERESTING evidence has been obtained on the possible origin of the minute, mysterious, and so far, unidentified particles whose presence in the atmosphere is vital to the formation of rain from supercooled cloud. This has resulted from a study of samples collected at high altitudes by U-2 aircraft operated by the U.S. Air Force from a base near Sale, Victoria. Thanks to the generous co-operation of the U.S. authorities, special dust-collecting filters were fitted to the U-2 aircraft. Samples of dust present at heights of 50,000-60,000 feet were obtained from ocean areas well to the south of Australia.

The results show unmistakably that sub-

sstantial numbers of particles occur at these high altitudes—very many more than can be accounted for if they all come from the Earth's surface. Support is thus given to a theory first advanced by Dr. E. G. Bowen in 1953 that an important source of these particles is the meteor dust which the earth picks up, in the course of its annual journey round the Sun, as it intersects the orbits of the various well-known streams of meteors. This meteoritic dust takes some 30 days to sink to the cloud-bearing levels of the atmosphere, and stimulates heavy rainfall when it arrives there if meteorological conditions happen to be favourable.

STUDIES IN THE ENZYME MAKE-UP OF *ALTERNARIA*

I. Qualitative Demonstration of Enzymes

S. N. DAS-GUPTA* AND J. P. VERMA

Department of Botany, Lucknow University
Lucknow

ABSTRACT

Experiments were conducted with three phytopathogenic species of *Alternaria* to find out their enzyme make-up. The presence of a large number of enzymes has been demonstrated in the three species. Phosphorylase, aldolase, dehydrogenases, amidases, deaminases, ribonuclease, nucleo-deaminases, glycerophosphatase and nucleophosphatases have been shown to be present in *Alternaria* for the first time.

ALIMTED aspect of enzyme system of *Alternaria* has received attention from previous workers (Szelenyi and Beeze, 1928; Uppal et al., 1938; Tandon and Srivastava, 1949; Coulson and Cinq-Mars, 1952; Torikata and Komai, 1952; Franke and Taha, 1952; Ozawa, 1952; Ozawa and Okamoto, 1953; Pomeranz, 1957; Meyers and Reynolds, 1959). The present series of investigations were undertaken with a view to elucidate the enzyme make-up of three authenticated species of *Alternaria*, viz., *A. tenuis* auct. sensu Wilshire (AT), *A. brassicola* (Schw.) Wiltshire (AB) and *A. raphani* Groves and Skolko (AR), isolated from their respective hosts *Althea rosea*, *Brassica oleracea* and *Raphanus sativus*. Of these *A. tenuis* has already been worked out (Tandon and Srivastava, 1949; Coulson and Cinq-Mars, 1952; Pomeranz, 1957; Meyers and Reynolds, 1959) though only briefly, whereas the other two species are metabolically unknown. The underlying idea behind these studies was to find out the possible correlation between the enzyme make-up of these strains and their pathogenicity. In this first paper of the series an account is given of the enzymes detected by means of qualitative procedures.

Pure monohyphal cultures of these species were utilized for investigation and periodically tested for purity. For the preparation of extra- and intracellular enzyme extracts, mycelia from young cultures (Brown, 1915) were utilized, as being the stage when maximum enzyme production is known to occur. The medium used to grow the fungi was that developed by Ashour (1954). For the preparation of enzymes the spores from each of the species were separately collected from their cultures by repeated floodings with sterile double glass-distilled water and centrifugations. 4 ml. of suspension thus

made, having spore content roughly to the order of 4×10^5 , were utilized to inoculate each flask containing 21 ml. of the medium, and incubated at 28°C. for 6 days, when a thin mat of young mycelium appeared. The contents of the flasks were then centrifuged at 5°C. at 3,000 rpm. for 30 minutes and the supernatants, stored with a layer of toluene in deep-freeze at -20°C., served as the extracellular enzyme extract.

The fungal mycelia, washed free of adhering media, were partially dried between folds of sterilized filter-papers and finally in a vacuum desiccator under vacuum and over calcium chloride. The dried mycelia were mixed with an equal quantity of acid-washed sand and crushed in glass pestles and mortars to yield fine powders, which were stored under dry conditions in deep-freeze.

For the extraction of enzymes, 0.2 gm. of the powder containing 0.1 gm. of the fungus material and 0.1 gm. of sand were suspended in 10 ml. of water or buffer at 4°C. with periodical shaking. After 16 hours the solutions were centrifuged at 3,500 rpm. for 20 minutes at 5°C., and the clear supernatants were directly used as the intracellular enzyme source. The presence of the enzymes in the intra- and extracellular extracts was tested by the usual procedures (the actual methods followed in each case have been referred to in appropriate places). Two types of controls, one with inactive enzyme (inactivated by autoclaving at 15 lb. for 15 minutes) and the other with sterile distilled water, were prepared for comparison with the tests. The results, where the enzymes have been grouped following the system adopted by Colowick and Kaplan (1955), are given in Table I.

The table shows the presence of a large number of enzyme systems and records for the first time the presence of phosphorylase, aldolase, dehydrogenases, amidases, deaminases, ribonuclease, nucleo-deaminases, glycerophosphatase and

* Present Address: Vice-Chancellor, University of Kalyani, Kalyani, Nadia, West Bengal.

TABLE I
Qualitative demonstration of enzymes

Enzyme	Substrate	Incubation time and temperature	Enzyme activity						Method	
			Intracellular			Extracellular				
			AT	AB	AR	AT	AB	AR		
I Carbohydrate metabolism										
1 Amylase	.. Starch (5%)	24 hrs. at 37° C.	+	+	+	+	+	+	Fehling's solution	
2 Invertase	.. Sucrose (1%)	do.	+	+	+	+	+	+	do.	
3 Raffinase	.. Raffinase (1%)	do.	+	+	+	+	+	+	do.	
4 Hemicellulase	.. Hemicellulose (Nutman, 1929) (1%)	do.	+	+	+	+	+	+	do.	
5 Maltase	.. Maltose (1%)	do.	+	+	+	+	+	+	Barfoed's reagent	
6 Cellulase	.. Filter-paper	15 days at 37° C.	+	+	+	+	+	+	Maceration	
7 Protopectinase	.. Potato discs	½-20 hrs. at 37° C.	+	+	+	+	+	+	do.	
8 Phosphorylase	.. Glucose 1-phosphate (0.5%)	1 hr. at 37° C.	+	+	+	Not done			Sumner <i>et al.</i> (1944, 1950)	
9 Aldolase	.. Fructose-1 : 6-diphosphate (M/20)	do.	+	+	+	do.			Sibley and Lehnninger (1949)	
II Lipid metabolism										
1 Lipase	.. Olive oil emulsion	7 days at 37° C.	+	+	+	+	+	+	Titration	
2 Butyrase	.. Ethyl acetate (2%)	3 days at 37° C.	+	+	+	+	+	+	do.	
III Citric acid cycle										
1 Dehydrogenases	.. Succinic acid	16 hrs. at 37° C.	+	+	+	Not done			Srikantan and Murti (1955)	
	Aspartic acid	do.	+	+	+	do.			do.	
IV Protein metabolism										
1 Proteolytic enzyme	.. Peptone (2%)	24 hrs. at 37° C.	+	+	+	+	+	+	Formal titration	
2 Erepsein	.. Casein (1%)	7 days at 28° C.	Not done		+	+	+	+	Medium around the fungal colonies became cleared	
3 Rennatase	.. Milk (fresh)	24 hrs. at 37° C.	+	+	+	+	+	+	Coagulation	
4 Urease	.. Urea (1%)	7 days at 37° C.	+	+	+	+	+	+	Ammonia aerated off and estimated by titration	
5 Amidases and Deaminases	De- minases l-glutamic acid (M/100)	90 mts. at 37° C.	+	+	+	Not done			Liberated ammonia estimated by nesslerization do.	
	dL-glutamic acid (M/50)	do.	+	+	+	do.			do.	
	L-glutamine (M/100)	do.	+	+	+	do.			do.	
	L-histidine (M/100)	do.	+	+	+	do.			do.	
	dl-histidine (M/50)	do.	+	+	+	do.			do.	
	d-histidine (M/100)	do.	+	+	+	do.			do.	
	dl-asparagine (M/50)	do.	+	+	+	do.			do.	
	dl aspartic acid (M/50)	do.	+	+	+	do.			do.	
	L-Asparagine (M/100)	do.	+	+	+	do.			do.	
V Nucleic acid metabolism										
1 Ribonuclease	.. Yeast RNA (4 mg./ml.)	2 hrs. at 37° C.	+	+	+	do.			Formation of pentoses estimated by Brown's (1946) orcinol reaction	
2 Nucleodeaminases	Adenine (M/100)	do.	+	+	+	do.			Nesslerization do.	
	Guanine (M/100)	do.	+	+	+	do.			do.	
	Xanthine (M/100)	do.	+	+	+	do.			do.	
	Uracil (M/100)	do.	-	-	-	do.			do.	
	AMP (M) (M/100)	do.	+	+	+	do.			do.	
	AMP (Y) (M/100)	do.	+	+	+	do.			do.	
	GMP (M/100)	do.	+	+	+	do.			do.	
	CMP (M/100)	do.	+	+	+	do.			do.	
	ATP (M/100)	do.	+	+	+	do.			do.	

TABLE I—Contd.

Enzyme	Substrate	Incubation and temperature	Enzyme activity						Method	
			Intracellular			Extracellular				
			AT	AB	AR	AT	AB	AR		
VI	Phosphate metabolism	Na-β-glycerophosphate (0.5%)	1 hr. at 37° C.	+	+	+	Not done	Phosphorus estimated (Sumner, 1944)		
1	Glycerophosphatase									
2	Nucleophosphatases	AMP (M) (M/100) ATP (M/100) GDP (M/100) CMP (M/100)	2 hrs. at 37° C. do. do. do.	+	+	+	do.	do.		
VII	Respiratory enzymes									
1	Catalase	Hydrogen peroxide (1%)	2 hrs. at 15° C.	+	+	+	+	+	Titration by KMnO ₄	
2	Oxidases and peroxidases	Tincture of guaiacum (2.5%) and H ₂ O ₂	4-24 hrs. at 37° C.	+	+	+	+	+	Colour change	
3	Laccase	.. Hydroquinone (1%)	16 hrs. at 37° C.	+	+	+	+	+	do.	
4	Tyrosinase	.. Tyrosine (saturated solution)	48 hrs. at 37° C.	-	-	-	-	-	do.	

+ denotes the presence of enzyme; — denotes the absence of enzyme.

nucleophosphatases, using various substrates, in the three species of *Alternaria* studied. Ren-natase, laccase, oxidase and peroxidase, earlier reported to be absent in the enzyme preparations of *A. tenuis* (Tandon and Srivastava, 1949), were found to be present in significant quantities in the present investigations. These qualitative studies showing significant activities of various enzyme systems give encouraging possibilities for quantitative investigations with regard to the distribution and kinetics of these enzymes in the species of *Alternaria*, which in turn may lead to a possible correlation between the enzyme activity and pathogenicity of these organisms possessing a wide host range. The results of such studies will be published soon.

1. Ashour, W. E., *Trans. Brit. Mycol. Soc.*, 1954, **37**, 343.
2. Brown, A. H., *Biochem. J.*, 1946, **60**, 39.
3. Brown, W., *Ann. Bot.*, 1915, **29**, 313.
4. Coulson, J. G. and Cinq-Mars, L., *In Thirty-second and Thirty-third Reports of the Quebec Society for the Protection of Plants* (1950 and 1951), 1952, pp. 232; Also in *Rev. Appl. Mycol.*, 1954, **33**, 467.
5. Colowic, N. O. and Kaplan, S. P., *Methods in Enzymology*, Academic Press, New York, 1955, **1**, **2**, **3** and **4**.

6. Franke, W. and Taha, E. E. M., *Chem. Berlin*, 1952, **85**, 913; Also in *Biol. Absts.*, 1954, **28**, 14665.
7. Meyers, S. P. and Reynolds, E. S., *Canadian J. Microbiol.*, 1959, **5**, 493.
8. Nutman, F. J., *Ann. Appl. Biol.*, 1929, **16**, 40.
9. Ozawa, J., *Rept. Ohara Inst. Agr. Research*, 1952, **40**, 110.
10. — and Okamoto, K., *Ibid.*, 1953, **41**, 17; Also in *Chem. Absts.*, 1953, **47**, 10070.
11. Pomeranz, Y., *Bull. Research Council Israel*, 1957, **6C**, 53; Also in *Chem. Absts.*, 1958, **52**, 3032.
12. Sibley, J. A. and Lehninger, A. L., *J. Biol. Chem.*, 1949, **177**, 859.
13. Sikantam, T. N. and Murti, C. R. K., *J. Sci. Ind. Res.*, 1955, **14C**, 206.
14. Sumner, J. B., *Science*, 1944, **100**, 413.
15. — Chou, J. C. and Bever, A. T., *Arch. Biochem.*, 1950, **26**, 1.
16. Szelenyi, G. V. and Beeze, G. V., *Rev. Appl. Mycol.*, 1928, **8**, 263 (1929).
17. Tandon, R. N. and Srivastava, J. P., *Proc. Natl. Acad. Sci. India*, 1949, **19B**, 13.
18. Torikata, H. and Komai, Y., *Ann. Phytopathol. Soc. Japan*, 1952, **16**, 63; Also in *Chem. Absts.*, 1953, **47**, 9433.
19. Uppal, B. N., Patel, M. K. and Kamat, M. N., *Ind. J. Agric. Sci.*, 1938, **7**, 413.

LETTERS TO THE EDITOR

DISSYMMETRY MEASUREMENTS OF HIGH POLYMER SOLUTIONS AT HIGH DILUTIONS

IT is known that for small molecules the scattering intensity at two angles ($I_\theta, I_{\pi-\theta}$) equally spaced about 90° is the same. This is no longer so when the size of the molecule becomes comparable to that of the wavelength of the light, because the light scattered from different parts of the molecule interferes hence the intensities are different in different directions. Thus there is a dissymmetry in the scattered light. The dissymmetry coefficient q is defined as

$$q = \frac{I_\theta}{I_{\pi-\theta}} - 1 \quad (1)$$

where I_θ and $I_{\pi-\theta}$ are the excess of scattering intensity at angles θ and $\pi - \theta$ due to solute. To find the size of the molecule in solution it is the usual practice to find q at different concentrations (i.e., 0.1 gm./100 c.c. to about 0.3 gm./100 c.c.) and the intrinsic dissymmetry coefficient [q] (the value of q at $C = 0$) is obtained by linear extrapolation of $1/q$ vs. C graph to $C = 0$. From the knowledge of [q] the length of the molecule is evaluated by well-known formula.

If the size and concentration are the only factors affecting the dissymmetry, the dissymmetry should tend to attain a constant value, below a certain concentration where the concentration contribution may become negligible. As a consequence in the plots of $1/q$ against ' C ' the portion of the curve at low concentrations should tend to be parallel to the C -axis. Recently¹⁻⁴ it has also been reported by many workers that the viscosity number n_{sp}/c of a polymer solution increases with decreasing concentration below a certain critical concentration (0.1%). This was explained by Torukawai *et al.*,⁵ by taking into consideration the expansion of polymer coil with dilution below a certain concentration. If this is the case an analogous effect should be observed with light scattering dissymmetry and hence with the graph $1/q$ vs. C at lower concentration region. Consequently the customary procedure of linear extrapolation of $1/q$ vs. C graph to $C = 0$ to obtain the size of the molecule is not entirely justifiable.

Frank⁶ had shown in respect of Polystyrene that such an analogous effect did not exist in light scattering behaviour. However in view of continued reports of viscosity abnormalities⁵ and the large

scatter of experimental data at low concentrations reported by Frank it is thought desirable that an investigation of dissymmetry of polymer solutions at very low concentrations where the scattering due to solution is comparable to that of the solvent should be undertaken to establish the validity or otherwise of the dissymmetry method.

Two narrow fractions of polymethyl methacrylate (PMM) one of high molecular weight (H) ($M_w = 1.14 \times 10^6$) were taken. Ethyl acetate was taken as a solvent because for this system the dn/dc is high (0.120), hence reliable results can be obtained. The light scattering data were observed at different concentrations between (0.4 gm./100 c.c. to 0.009 gm./100 c.c.) and for each concentration at the angles $45^\circ, 90^\circ$ and 135° . The readings are shown in Table I

TABLE I
Light scattering data for fractions H and L

Fraction H Conc. gm./100 c.c.	$1/q$	Fraction L Conc. gm./c.c.	$1/q$
0.092	1.63	0.208	8.85
0.136	1.83	0.357	10.99
0.201	1.96	0.612	10.99
0.297	1.86	1.050	11.90
0.438	2.13	1.800	12.99
0.647	2.17	1.960	14.08
0.955	2.38	2.240	14.49
1.409	3.01	2.690	15.62
2.080	3.27	3.420	17.56
2.290	3.55	4.160	19.23
3.300	5.21	..	..
4.240	7.09	..	..
4.600	7.19	..	..

and the graphs plotted between $1/q$ and C are shown in Fig. 1.

From the graphs it is evident that the linear relationship between $1/q$ and C holds good up to the lowest concentration 0.009 gm./100 c.c. within the limits of experimental errors. This is not an expected result and it looks as though a new factor affecting the dissymmetry of the molecule begins to operate at very low dilution. Or it may be that the concentration contribution to dissymmetry is still finite even at concentrations as low as 0.009 gm./100 c.c. In either case an effect analogous to the abnormal viscosity behaviour at low concentrations does not seem to exist in the light scattering pattern. However, the results justify the conventional method of

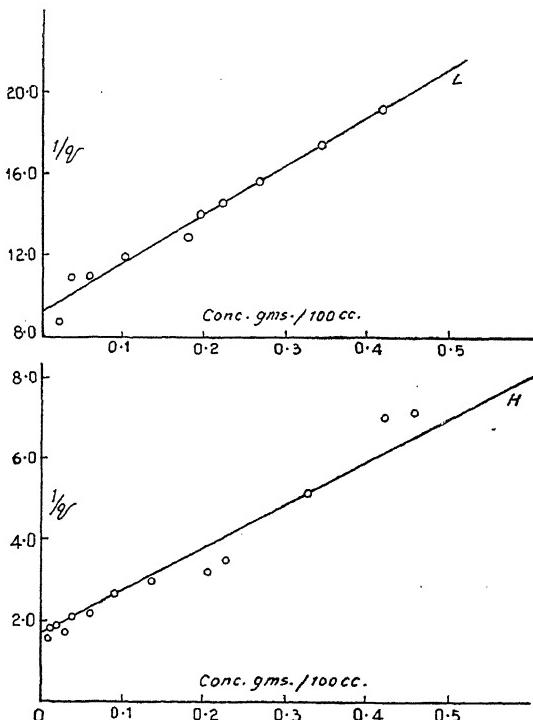


FIG. 1. Reciprocal dissymmetry coefficient ($1/q$) versus concentration. PMM—Ethyl Acetate.

extrapolating $1/q$ vs. C graph to $C = 0$ to obtain the size of the molecule.

Physics Department, V. V. VARADAIAH,
Osmania University, V. S. R. RAO.
Hyderabad-7 (A.P.), India,
September 14, 1960.

1. Streeter, D. J. and Boyer, R. F., *J. Polymer Sci.*, 1954, **14**, 5.
2. Batzer, H., *Makromol. Chem.*, 1954, **12**, 145.
3. Umstalter, H., *Ibid.*, 1954, **12**, 94.
4. Patat, F. and Elias, H. G., *Ibid.*, 1954, **16**, 40.
5. Torukawai and Kazuhisa Saito, *J. Polymer Sci.*, 1957, **26**, 213.
6. Frank, H. P., *Ibid.*, 1955, **17**, 130.

ULTRASONIC VELOCITY IN SOME INORGANIC SOLUTIONS AND MELTS

It is known that in many organic solute-solvent systems,¹ the plots of sound velocity vs. percentage weight of the solute are linear. In such cases the velocity for 100% of the solute can be evaluated by extrapolation of the linear graphs. It has been found² that, in the case of some organic substances with low melting temperatures, the extrapolated value is independent of the solvent and corresponds to the velocity in the liquid phase at the melting point.

When such a procedure is adopted in the case of some inorganic substances³ (alkali halides and nitrates with high melting points), the extrapolated value is found to be very much higher than the velocity in the melt. This discrepancy has been attributed to the large difference between the temperatures at which these substances exist as liquids and the room-temperature at which the data on solutions are collected. To clarify this point further, it is proposed to study the sound velocity in aqueous solutions of some low melting inorganic substances (hydrated salts) and correlate the results with the sound velocities in their melts.

A variable-path interferometer working at 720 Kcs. has been employed to determine the ultrasonic velocity. The estimated error in velocity measurement is $\pm 0.15\%$. Measurements on solutions are made at $30 \pm 0.5^\circ\text{C}$.

The variation of ultrasonic velocity with percentage weight of the solute for aqueous solutions of sodium thiosulphate, potassium sodium tartrate and calcium nitrate is shown in Fig. 1. The velocity varies linearly in all cases.

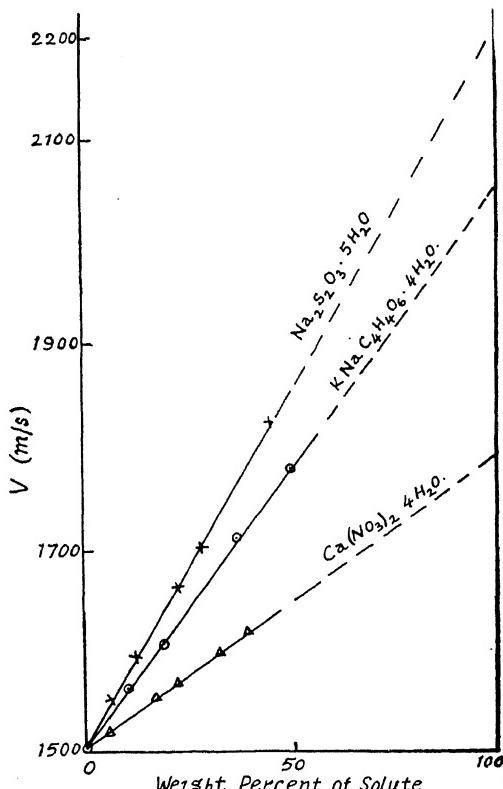


FIG. 1. Variation of ultrasonic velocity in aqueous solutions of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$, $\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ and $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$.

The linear plots are extrapolated to get the velocity corresponding to 100% of the solute. The values of the velocity so obtained are given in column 2 of Table I. These values are compared with the sound velocities in the corresponding melts at the melting point.

TABLE I
Ultrasonic velocities in solutions and melts

Substance	Ultrasonic velocity in m./sec.		
	From solution data	At the melting point	
$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$..	2192	2176 (45° C.)
$\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$..	2040	2052 (75° C.)
$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$..	1790	1800 (50° C.)

Ultrasonic velocity in the molten sodium thiosulphate has been determined in the present investigation and the data for the other two substances are taken from the work of Padmini and Rao.⁴ Comparison of columns 2 and 3 shows that the characteristic velocities obtained from the data on solutions correspond to the velocities at the melting points of the substances. This result is in agreement with our earlier observations.²

In the case of substances with high melting points, a study of a temperature-independent property like molar sound velocity³ may be helpful.

The author takes this opportunity to thank Dr. J. Bhimasenachar for his encouragement.

Department of Physics, S. V. SUERAHMANYAM.
S.V. University,
Tirupati, October 28, 1961.

- Schaffs, W., *Z. physik.*, 1937, **105**, 658.
- Subrahmanyam, S. V. and Bhimasenachar, J., *J. Acoust. Soc. Am.*, 1960, **32**, 703.
- and —, *J. Phys. Soc. Japan*, 1961, **16**, 1447.
- Padmini, P. R. K. L. and Ramachandra Rao, B., *Nature*, 1961, **191**, 694.

DIAMAGNETIC SUSCEPTIBILITIES OF SOME ISOMERIC MONOSUBSTITUTED NITROBENZENES-EFFECT OF THE POSITION OF THE SUBSTITUENT GROUP ON SUSCEPTIBILITY AND THE SUSCEPTIBILITY CONTRIBUTION OF THE NITRO-GROUP

THE effect of the nature and position of a substituent on the susceptibility of isomeric disubstituted benzenes has been examined by several investigators notably by French,¹ Kido,² Cabrera and Fahlenbrach,³ Bhatnagar and Mathur,⁴ and Khatavkar and Khanolkar.⁵ The

results tend to indicate that the susceptibilities of these position isomers, although different from each other, do not show any definite order among themselves. French¹ has drawn attention to the anomalous effect on the susceptibility of a compound due to the presence of a nitro-group, there being an appreciable difference between the susceptibilities of isomers when a nitro-group is one of the substituents and when this group is absent. In the present investigation susceptibilities of a large number of mono-substituted nitrobenzenes have been examined with a view to study the effect of the position of the substituent group on the susceptibility of the compound and to determine the susceptibility contribution of the NO_2 -group in these isomerides.

EXPERIMENTAL

All materials used in the present investigation were purified using all-glass apparatus. Solids of B.D.H. pure grade were purified by recrystallisation from pure suitable solvents and their purity was checked by determining their melting points and comparing them with those reported in the literature. Liquids of the same grade were twice redistilled and their purity

TABLE I

Compound	χ	χ_m	$\Delta \chi_m$
Toluene	..	64.74	..
<i>o</i> -Nitrotoluene	0.527	72.19	7.45
<i>m</i> -Nitrotoluene	0.530	72.61	7.87
<i>p</i> -Nitrotoluene	0.510	69.87	5.13
Chlorobenzene	..	70.53	..
<i>o</i> -Chloronitrobenzene	0.512	80.65	10.12
<i>m</i> -Chloronitrobenzene	0.483	76.07	5.54
<i>p</i> -Chloronitrobenzene	0.505	79.54	9.01
Phenol	..	60.70	..
<i>o</i> -Nitrophenol	0.505	70.20	9.50
<i>m</i> -Nitrophenol	0.472	65.60	4.90
<i>p</i> -Nitrophenol	0.456	63.39	2.69
Anisole	..	71.97	..
<i>o</i> -Nitroanisole	0.492	75.28	3.31
<i>m</i> -Nitroanisole	0.520	79.56	7.59
<i>p</i> -Nitroanisole	0.518	79.25	7.28
Aniline	..	62.69	..
<i>o</i> -Nitroaniline	0.481	66.37	3.68
<i>m</i> -Nitroaniline	0.491	67.76	5.07
<i>p</i> -Nitroaniline	0.480	66.24	3.55
Acetanilide	..	82.62	..
<i>o</i> -Nitroacetanilide	0.514	92.53	9.91
<i>m</i> -Nitroacetanilide	0.437	84.07	1.45
<i>p</i> -Nitroacetanilide	0.486	87.48	4.86
Benzaldehyde	..	59.99	..
<i>o</i> -Nitrobenzaldehyde	0.475	71.73	11.74
<i>m</i> -Nitrobenzaldehyde	0.446	67.35	7.36
<i>p</i> -Nitrobenzaldehyde	0.433	65.39	5.40

checked by determining their boiling points and refractive indices. *m*-Nitroacetanilide and *m*-Nitroanisole were prepared using standard methods of preparation; they were purified and their purity checked by their melting points.

Magnetic susceptibilities were measured by a modified form of Guoy balance described by Prasad *et al.*⁶ The error of measurement was found to be less than 1%. These values are given in Table I, wherein x and x_m denote the specific and molar susceptibilities respectively, expressed in -1×10^{-6} C.G.S. Units. The susceptibility contribution of the nitro-group in the isomers has been determined by calculating the differences between the magnetic susceptibilities of substituted nitro-derivatives and of the corresponding parent substances. The values of Δx_m for the parent substances required for this purpose were determined by the authors. The x_m value for phenol in Table I, however, has been taken from literature. The Δx_m values [$x_m(\rightarrow C-NO_2) - x_m(\rightarrow C-H)$] are given in the last column of Table I.

DISCUSSION

According to French¹ in disubstituted benzene derivatives the susceptibility of the ortho compound has the highest value when two electron repelling substituents are in ortho position to each other. In compounds containing two electron attracting substituent groups the susceptibility of the meta compound has the highest magnitude. She has attributed this to the differences in the distribution of the electron density at the ortho and meta positions respectively due to the presence of these substituents in the benzene nucleus. Among the seven mono-substituted nitrobenzenes studied in this investigation the nitrobenzaldehydes are the only ones containing electron withdrawing substituents. The susceptibility of the meta isomer in these compounds should be the highest according to considerations referred to above. The observed values of x_m , however, do not support these views. In the remaining sets of isomeric mono-substituted nitrobenzenes no definite order emerges from the observed x_m values. For nitroanilines the results confirm the order $m > o > p$ obtained by Mikhail.⁷

A critical examination of the results indicates that the magnitude of the difference in the susceptibilities of *o*- and *m*-compounds is of the order of 4.5 units in several cases.

French¹ has observed an *o-m* difference of the same order in the case of dinitrobenzenes and nitrobenzoic acids. In nitroacetanilides, however, this difference is as high as eight units.

Again the magnitude of the difference between *m*- and *p*-, and *o*- and *p*-compounds is relatively smaller. The results tend, in general, to confirm anomalous effects observed by French¹ and other investigators including Pascal in the case of compounds containing the nitro-group.

The values of Δx_m (Table I) show that the susceptibility contribution of the nitro-group varies from 1.45 to 11.74 but ranges from 3.5 to about 8 for a majority of the substituents. Although the magnitude of this value is highest in the meta position for the nitro-toluenes and nitroanilines as found by Baddar and Sugden,⁸ the same order cannot be extended to other nitro-derivatives. In the case of isomeric nitro-derivatives containing the Cl, OH, NHCOCH₃ and CHO substituents Δx_m values are not only the highest but substantially higher (9.5 to 11.74 units) than the average range for the *o*-isomers.

An attempt was also made to correlate the magnetic susceptibility of the monosubstituted nitrobenzenes with physical properties such as density, boiling point, refractive index, molecular volume, etc., and also with the size of the substituent. An examination of the results failed to establish any close relationship between magnetic susceptibility and these properties.

The authors wish to thank Dr. D. D. Khanolkar, Institute of Armaments Studies, Kirkee, Poona-3, for initiating the problem and directing some of the experimental work.

Chemistry Department, S. M. SHAH.
Institute of Science, R. N. MERCHANT.
Bombay, May 20, 1961. M. G. DATAR.

1. French, *Trans. Faraday Soc.*, 1945, **41**, 676.
2. Kido, *Sci. Rep. Tohoku Imp. Univ.*, 1936, **24**, 701.
3. Cabrera and Fahlenbrach, *Z., Physik.*, 1934, **89**, 682.
4. Bhattacharya and Mathur, *Phil. Mag.*, 1930, **10**, 101; 1931, **11**, 914.
5. Khatavkar and Khanolkar, *Jour. of Sci. Ind. Res.*, 1959, **8B**, 25.
6. Prasad *et al.*, *Proc. Indian Acad. Sci.*, 1944, **20 A**, 224.
7. Mikhail, *J. Chem. Phys.*, 1953, **21**, 1004.
8. Baddar and Sugden, *J. Chem. Soc.*, 1950, p. 308.

MAGNETISM AND MOLECULAR STRUCTURE: THE ESTIMATE OF METAL-NITROGEN BOND IN CADMIUM CHLORIDE COMPLEXES OF ORGANIC BASES

In continuation of our previous work on zinc chloride complexes of organic bases reported in this journal¹ we now submit the results of the

study of complexes of cadmium chloride with the same organic bases.

The method of preparation and the measurement of magnetic susceptibilities of these complexes is the same as described in the previous work. The results are given in Tables IA and IB.

and the *ortho*-toluidine complexes as compared to the Cd-N in the diamine are more significant than the corresponding changes in χ_p term. The λ values tend to become more negative in the order *o*-toluidine > pyridine > aniline > *p*-toluidine > *m*-xylidine > quinoline > *m*-toluidine. This order is similar to that

TABLE IA

Name of the complex	χ	χ_m	Name of Ligand	χ_m
1 Dipyridine cadmium chloride	..	0.457	Pyridine	46.92
2 Diquinoline cadmium chloride	..	0.526	Quinoline	87.52
3 (i) Dianiline cadmium chloride-dihydrate	..	0.511	(i) Aniline	62.55
(ii) Anhydrous	..		(ii) 186.26	
4 (i) Ditoluidine cadmium chloride-dihydrate (<i>Ortho</i>)	0.546	(i) 236.50	<i>o</i> -toluidine	74.54
(ii) Anhydrous	..	(ii) 215.56		
5 Ditoluidine cadmium chloride (<i>Meta</i>)	..	0.503	<i>m</i> -toluidine	74.40
6 do. (<i>Para</i>)	..	0.515	<i>p</i> -toluidine	72.58
7 Dixylylidine cadmium chloride (<i>Meta</i>)	..	0.545	<i>m</i> -xylidine	86.90
8 Diamine cadmium chloride	Ammonia (liquor)	19.00

TABLE IB

Complex	χ_m	$\Delta \chi_m$	Ligand	$\chi_{m'}$	$\Delta \chi_{m'}$	$\frac{\Delta \chi_{m'} - \Delta \chi_{m'}}{2}$ = λ per Cd-N bond
CdCl ₂ .2 C ₅ H ₅ N	..	156.00	2 C ₅ H ₅ N	93.84	55.84	+0.07
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		
CdCl ₂ .2 C ₉ H ₇ N	..	232.30	2 C ₉ H ₇ N	174.04	137.04	-2.37
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		
CdCl ₂ .2 C ₆ H ₅ NH ₂	..	186.26	2 C ₆ H ₅ NH ₂	125.10	87.10	-0.42
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		
CdCl ₂ .2 C ₇ H ₇ NH ₂ (<i>Ortho</i>)	215.56	86.25	2 C ₇ H ₇ NH ₂ (<i>Ortho</i>)	149.08	111.08	+2.23
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		
CdCl ₂ .2 C ₇ H ₇ NH ₂ (<i>Meta</i>)	199.90	99.89	2 C ₇ H ₇ NH ₂ (<i>Meta</i>)	148.80	110.80	-5.45
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		
CdCl ₂ .2 C ₇ H ₇ NH ₂ (<i>Para</i>)	204.70	104.69	2 C ₇ H ₇ NH ₂ (<i>Para</i>)	145.16	107.16	-1.23
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		
CdCl ₂ .2 C ₈ H ₉ NH ₂ (<i>Meta</i>)	232.00	131.99	2 C ₈ H ₉ NH ₂ (<i>Meta</i>)	173.80	135.80	-1.90
CdCl ₂ .2 NH ₃	..	100.01	2 NH ₃	38.00		

It is seen from the results that the λ values are positive in some cases and negative in others. In the study of zinc chloride complexes with organic bases² it was pointed out that the observed values of magnetic susceptibilities were always lower than their experimentally computed ones assuming strict additivity. The deviations from additivity were attributed to the changes in the χ_d and χ_p terms of Van Vleck's equation, as a result of the combination of the anhydrous salt with the ligand. It is obvious that the λ values in this case also include effects due to changes in χ_d and χ_p terms in these complexes as compared to the corresponding contribution in diamine. The positive values of λ indicate that changes in χ_d term arising from Cd-N bond in the pyridine

observed for zinc chloride complexes except for *m*-toluidine and *m*-xylidine.

Department of Chemistry, V. G. SONALKAR,
Institute of Science, M. G. DATAR.
Bombay-1, July 6, 1961.

1. Datar and Sonalkar, *Curr. Sci.*, 1960, **29**, 468.
2. — and —, *J. Univ. Bombay*, November issue (In press).

GRAVIMETRIC DETERMINATION OF CERIUM (IV) AND ITS SEPARATION FROM RARE-EARTHS USING 1-HYDROXY XANTHONE

A NUMBER of organic reagents¹⁻³ have been recommended for the gravimetric estimation of Cerium (IV). However most of these do not

separate it conveniently from trivalent rare-earths. The Iodate method⁴ which is generally used for the estimation and separation of Cerium from other rare-earths involves a number of operations.⁵ 3-Acetyl-4-hydroxy Coumarin effectively separates Cerium (IV) from large quantities of lanthanum, yttrium and gadolinium.⁶

1-hydroxy xanthone has been used for the gravimetric determination of uranium and thorium, in presence of Cerium (III) and lanthanum, but not in presence of Cerium (IV).⁷ It has now been found that 1-hydroxy xanthone in alcoholic solution, instantaneously forms a yellowish-brown complex with ceric salts, which gets readily separated on dilution with water. This reaction is quantitative between pH 2·0 and 8·5, and quantities as low as 5·0 mg. of CeO₂ have been estimated. The reagent does not form any complex with lanthanum, yttrium and gadolinium and can be used for the separation and estimation of Cerium (IV) from large quantities of these elements.

1% 1-hydroxy-xanthone ethanolic solution was used. Metallic salts were either of A.R. or Pro Analysi quality. Gadolinium nitrate solution was made from Gd₂O₃ (Johnson Matthey). Dilute hydrochloric acid, ammonium acetate and ammonium hydroxide were used for pH adjustment, and pH measurements were taken with a Beckman pH meter using a suitable glass electrode.

DETERMINATION OF CERIUM (IV) WITH 1-HYDROXY XANTHONE

To 100 ml. of Cerium (IV) ammonium nitrate solution containing about 20 mg. of CeO₂, 25 ml. of alcohol and 10 ml. of 1% ethanolic solution of 1-hydroxy xanthone were slowly added with constant stirring. The yellowish-brown complex thus formed was heated on a water-bath to completely remove alcohol. After cooling, on the addition of water (100 c.c.) the Cerium complex along with the excess of the reagent got precipitated. The flocculent precipitate was filtered through Whatman filter-paper No. 40, washed with water, dried and ignited to CeO₂. The results obtained are given in

TABLE I

Wt. of CeO ₂ taken (by oxine method) mg.	Wt. of CeO ₂ found (by 1-hydroxy xanthone method) mg.
5·0	5·0
11·3	11·3
20·0	20·0
22·4	22·4
40·1	40·0
50·0	50·1

Table I. The sulphate ions interfere in this estimation while chloride and nitrate ions are without any effect.

EFFECT OF PH ON THE FORMATION OF THE CERIC COMPLEX

The effect of pH on the precipitation of the complex was studied by using ammonium acetate-ammonium hydroxide buffer for higher pH and dilute hydrochloric acid for lower pH. It was found that the precipitation of ceric complex is complete between pH 2·0 and 8·5 (Table II).

TABLE II

Wt. of CeO₂ taken = 20·0 mg.
Wt. of CeO₂ found:

mg. pH	4·2	9·4	20·0	20·0	20·0	20·0	20·0
	1·0	1·5	2·0	3·0	5·0	7·0	8·5

DETERMINATION OF CERIUM IV IN THE PRESENCE OF THE RARE-EARTHS

As the reagent does not form any complex with trivalent rare-earths, the procedure for the determination of Cerium (IV) in their presence is the same as for Cerium (IV) alone. The precipitate before ignition was thoroughly washed with water.

TABLE III

Estimation of Cerium (IV) in presence of lanthanum (pH 2·0-7·0)

Wt. of CeO ₂ taken, mg.	Wt. of La ₂ O ₃ added, mg.	Wt. of CeO ₂ found, mg.
20·0	19·9	20·0
20·0	29·8	20·0
20·0	39·8	20·0
20·0	49·7	20·0
20·0	99·5	20·0
20·0	199·0	20·0

TABLE IV

Estimation of Cerium (IV) in presence of Yttrium (pH 2·0-7·0)

Wt. of CeO ₂ taken, mg.	Wt. of Y ₂ O ₃ added, mg.	Wt. of CeO ₂ found, mg.
20·0	23·70	20·0
20·0	35·05	20·0
20·0	47·40	20·0
20·0	58·75	20·0
20·0	118·50	20·0
20·0	237·00	20·0

Cerium (IV) can, thus, be estimated in presence of large quantities of Lanthanum, Yttrium and Gadolinium.

TABLE V

Estimation of Cerium (IV) in presence of gadolinium pH (2·0-7·0)

Wt. of CeO ₂ taken, mg.	Wt. of Gd ₂ O ₃ added, mg.	Wt. of CeO ₂ found, mg.
20·0	20·04	20·0
20·0	30·06	20·0
20·0	40·08	20·0
20·0	50·10	20·0
20·0	100·20	20·0
20·0	200·40	19·8

SUMMARY

1-hydroxy xanthone has been used for the estimation of Cerium (IV) at pH 2·0 to 7·0. As the reagent does not form any complex with other trivalent rare-earths, the estimation of Cerium (IV) can be carried in presence of large quantities of these.

The authors are grateful to Prof. T. R. Seshadri, F.R.S., Head of the Department, for his keen interest and helpful discussions.

Dept. of Chemistry, BRAHM DEV.
University of Delhi, B. D. JAIN.
Delhi-6 (India), October 3, 1961.

- Jefferson A. M., *J. Amer. Chem. Soc.*, 1902, **24**, 540.
- Pirtea, T., *Bull. Chem. Soc., Romane Chim.*, 1937, **39**, 83; *C.A.*, 1940, **34**, 2277.
- Jain, B. D. and Singhal, S. P., *J. Sci. Industr. Res.*, 1960, **19 B**, 494.
- Brinton, P. H. M. P. and James, C., *J. Amer. Chem. Soc.*, 1919, **41**, 1080.
- Schoeller, W. R. and Powell, A. R., *The Analysis of Minerals and Ores of the Rarer Elements* Charles Griffin & Co., Ltd. (London), Third Ed., 1955, p. 101.
- Bhat, A. N. and Jain, B. D., *J. less common Metals*, 1961, **3**, 259.
- Brahm Dev and Jain, B. D., under publication.

A COMPACT CALOMEL REFERENCE ELECTRODE PARTICULARLY USEFUL IN APPLIED ELECTROCHEMICAL INVESTIGATIONS

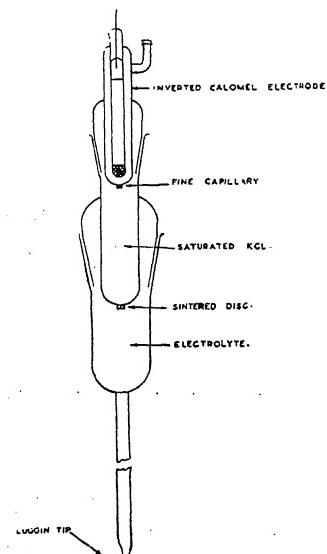
A KNOWLEDGE of the potential of a working electrode helps considerably in the understanding of electrochemical processes. The design considerations for a reference electrode are:—(1) reproducibility and constancy of the potential of the reference electrode; (2) minimum contamination of the cell electrolyte and reference electrode arising from diffusion (fritted glass discs, fine capillaries, agar-agar bridges are generally used to cut down diffusion); (3) minimum iR drop (whereas, in polarography, for example, the microampere order of current automatically makes the drop negligible; in

cells, where tens or hundreds of milliamperes pass, the drop is considerable, and the reference electrode is, therefore, made to terminate in a fine capillary—"Luggin tip"—which is brought as close to the working electrode as possible).

The agar-agar bridge suffers from two disadvantages:—(a) there is a possibility of contaminating the bath with organic impurities; (b) instability of the agar-agar comes in the way of high-temperature ($> 50^\circ \text{C}$) studies.

An alternative method consists in using a 4-unit arrangement—electrolytic cell, one beaker containing saturated KCl, and the SCE. The various units are connected with bridges, one of the bridges terminating in a Luggin tip. This arrangement, however, is very unwieldy to manœuvre in applied investigations where cells (generally, large cells) are designed for purposes other than potential measurement. The external bridges are responsible for the lack of manœuvrability. They have been eliminated, in some cases, by choosing a reference electrode employing the same electrolyte as that in the cell. For example, Sanghi and Wynne-Jones¹ used a Hg/HgO/KOH reference electrode in a study of the anodic behaviour of zinc in KOH solutions. This approach, however, is not so useful where a reference electrode has to be designed to work in varied applied investigations. A compact, single, integrated unit incorporating bridge and Luggin tip is essential. One such design is presented below.

The assembly (Fig. 1) consists of an inverted



calomel* electrode (prepared as described by Chilton *et al.*² fitted into a tube containing saturated KCl, which in turn fits into a tube containing the cell electrolyte. The saturated KCl tube has a small sintered glass disc to permit electrolyte contact. The tube containing cell electrolyte) terminates in a Luggin tip.

The central KCl tube minimises contamination of the SCE by diffusion of the bath, while the outer tube of electrolyte minimises contamination of the bath by KCl. Since ground-glass joints are employed, mixing of solutions by flow due to differences in level is absent. Further, no suction-filling of the tubes is required.

The above type of reference electrode is very convenient to handle. The potential of the reference electrode remained constant even after its use in a 24-hour electrolysis experiment thereby indicating that practically no contamination occurs.

This design, however, suffers from one drawback. Since a sintered disc and a fine capillary are used, the electrode has a resistance of the order of a few thousand ohms (ten thousand ohms). The resistance depends on the coarseness of the disc and the bore of the capillary. The high resistance necessitates the use of a vacuum-tube voltmeter with a large enough input impedance.

We thank Dr. A. K. N. Reddy, Senior Scientific Officer, for helpful suggestions, and Professor K. S. G. Doss, Director for his interest in the work.

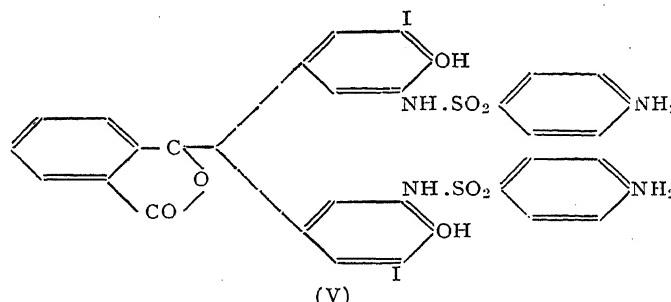
Central Electrochemical S. R. RAJAGOPALAN.

Research Institute, B. V. K. S. R. A. TILAK.
Karaikudi, August 8, 1961.

SULPHONAMIDOIODOPHTHALEINS

HALOGENATED organic compounds such as chiniofon,¹ chloroquine,² iodophthalein,³ phenoltetrachlorophthalein,⁴ etc., are widely used in medicine and pharmacy. The present work was undertaken to synthesize and study the pharmacological properties of sulphanamidoiodophthaleins.

Phenolphthalein was nitrated with acetic-nitric acid mixture at 10-15°C. to 3', 3"-dinitrophenolphthalein (I),⁵ m.p. 198-99°C. (I) in alkaline solution was iodinated with iodine in potassium iodide to 5', 5"-diido-3', 3"-dinitrophenolphthalein (II), m.p. 253-55°C. (dec.) ; yield 84-87%. (Found : C, 36.128 ; H, 1.631 ; N, 4.104 ; I, 38.210. Calcd. : C, 36.390 ; H, 1.526 ; N, 4.244 ; I, 38.450. (II) was reduced to 5', 5"-diido-3', 3"-diaminophenolphthalein (III) which does not melt up to 360°C.; yield 40-41%. (Found : C, 39.820 ; H, 2.428 ; N, 4.517 ; I, 42.060. Calcd. : C, 40.020 ; H, 2.351 ; N, 4.668 ; I, 42.290). The amino-compound (III) on condensation with N-acetylsulphanilyl chloride in alcohol acetone mixture (1:1) in presence of pyridine yielded 5', 5"-diido-3', 3"-diacetyl-sulphanilylamidophenolphthalein (IV) m.p. 228-30°C. (dec.). (Found : C, 43.610 ; H, 2.681 ; N, 5.472 ; S, 6.214 ; I, 25.700. Calcd. : C, 43.470 ; H, 2.836 ; N, 5.632 ; S, 6.448 ; I, 25.520). (IV) on hydrolysis with 4% aqueous sodium hydroxide gave 5', 5"-diido-3', 3"-disulphanilyl-amidophenolphthalein (V), m.p. 210-12°C. (dec.) ; yield 85-90%. (Found : C, 41.982 ; H, 2.513 ; N, 5.940 ; S, 7.174 ; I, 28.060. Calcd. : C, 42.230 ; H, 2.657 ; N, 6.154 ; S, 7.046 ; I, 27.880).



* Instead of an inverted calomel electrode a normal calomel electrode with minimum diffusion can also be used.³

1. Sanghi, I. and Wynne Jones, W. F. K., *Proc. Ind. Acad. Sci.*, 1958, 47A, 49.
2. Chilton, J. M., Cole, J. W. and Leake, P. H., *J. Chem. Ed.*, 1950, 27, 560.
3. Delahay, P., *Instrumental Analysis*, The MacMillan Company, New York, 1957, p. 28.

(V) is a colourless, amorphous solid, soluble in alcohol and acetone and insoluble in ether. It dissolves in dilute alkali with a blue colour and in dilute acid with a yellow colour and gives green colour with ferric chloride.

Further work and the pharmacological investigations are in progress. Details of these investigations will be published elsewhere.

We are thankful to the college authorities for granting us facilities to carry out the work.

Dep. of Pharm. Chem.,
L.M. College of Pharmacy,
Ahmedabad-9,
June 29, 1961.

C. R. MEHTA,
J. R. KALKE,
N. B. SHAH.

1. Claus, *German Pat.*, 1892, **72**, 942; 1894, **78**, 880; *Act. Phurm.*, 1893, **231**, 704.
2. Surrey and Hammer, *J. Amer. Chem. Soc.*, 1946, **68**, 113.
3. Goodman, L. S. and Gilman, A., *The Pharmacological Basis of Therapeutics*, II Edn., MacMillan Company, New York, 1955, p. 1173.
4. Jenkins, G. L. and Hartung, W. H., *The Chemistry of Organic Medicinal Products*, III Edn., John Wiley & Sons, Inc., New York, 1949, p. 243.
5. Van Kampen, E. J., *K. Prakt. Chir.*, 1952, **71**, 954; through *Chem. Abstr.*, 1953, **47**, 8677.

DISTRIBUTION OF NICOTINAMIDE DEAMIDASE IN GERMINATING PULSES

An enzyme system capable of deamidating nicotinamide to free nicotinic acid and ammonia was demonstrated for the first time in *Lactobacillai*,¹ yeast² and *Mycobacteria*³ and later in *Neurospora crassa*⁴ and the rice moth larva⁵ and recently in pea seedlings.⁶ The presence of nicotinamide-deamidating enzyme in various germinating pulses like green gram (*Phaseolus radiatus*), black gram (*Phaseolus mungo*), Bengal gram (*Cicer arietinum*), horse gram (*Dolichos biflorus*), red gram (*Cajanus indicus*), French bean (*Phaseolus vulgaris*) and Indian corn (*Zea mays*) and the intracellular locale of the enzyme in the green gram seedlings are reported in this note.

Germination of the various pulses was carried out, inside a sterile petri dish, over a filter circle, in diffused daylight in a sterile chamber at room-temperature. Homogenates of tissues, namely, the cotyledons, the epicotyl and the hypocotyl were prepared in the chilled mortar and suspended in 2.5% solution of sodium chloride. The complete experimental system contained (in 2 ml.): 0.5 ml. of 0.4 M Tris (hydroxymethyl amino-methane) buffer at pH 7.0; 0.5 ml. of nicotinamide solution (4 μ moles) and 1 ml. of the enzyme preparation. In the blank 0.5 ml. of water replaced the nicotinamide solution. Incubation was at 37° C. for 2 hours at the end of which the free nicotinic acid released was determined microbiologically using *Leuconostoc mesenteroides* 9135, which responds specifically to free nicotinic acid.⁷

The distribution of this enzyme in various pulses was first studied. It was found that the

tissues of all pulses tested are able to deamidate nicotinamide *in vitro*, the activity decreasing in the order: green gram, black gram, Bengal gram, Indian corn, red gram, French bean and horse gram. Since the tissues of the green gram seedlings possess a high nicotinamide deamidase activity, the activity of the enzyme at various periods of germination was tried and it was found that the deamidase activity of green gram increases during germination, the maximum being reached in 48 hours, beyond which no enhancement in the activity is observed. Moreover, the cotyledons exhibit more activity than the hypocotyl and epicotyl.

Since the green gram seedlings contained maximum enzyme activity the intracellular locale of the enzyme was investigated. The homogenate of the germinated seedlings was prepared in ice-cold sodium chloride (2.5%) solution, using Teflon-pestle homogeniser assembly at 0° C. The fractionation of the homogenate into particulate components and the soluble supernatant was carried out according to the method of Schneider,⁸ on an International refrigerated centrifuge (Model PR-2) and the fractions were then assayed for enzyme activity. From the results presented in Table I, it is obvious that

TABLE I
Distribution of nicotinamide deamidase activity in sub-cellular components of green gram seedlings

[Incubation system: 0.5 ml. of 0.4 M Tris (hydroxymethyl amino-methane) buffer pH 7.0, 0.5 ml. of nicotinamide (4 μ moles) and 1 ml. of cell fraction. Incubation at 37° C. for 2 hours and the enzymes activity determined as described earlier.]

Fraction	Nicotinic acid released by 1 ml. of cell fraction (μ gm.)	Per cent. total activity	Nitrogen* in 1 ml. of cell fraction (mg)	Nicotinic acid released/mg. of nitrogen (μ gm.)
Unfractionated homogenate	200	100	1.85	108.1
Fraction I (particulate materials corresponding to nuclei, mitochondria and microsomes obtained after centrifugation at 25,000 g.)	20	10	..	..
Fraction II Supernatant	180	90	0.75	210

* Nitrogen present in enzyme preparation and insoluble in trichloro acetic acid, determined by nesslerization of a sulphuric acid hydrogen peroxide digest.

the nicotinamide deamidase activity is localised almost exclusively in the soluble portion of the cytoplasm and the small amount of activity, associated with the fraction sedimenting at 25,000 g., is probably due to the presence therein of a small percentage of intact cells.

The presence of the enzyme nicotinamide deamidase in various germinating pulses points out that the plant system resembles the organisms, *Neurospora crassa*, the rice moth larva (*Corypha cephalonica* St.) and the green pea in being apparently incapable of methylating nicotinamide,⁴⁻⁶ and it can be suggested that methylation and deamidation of nicotinamide are probably alternative pathways in the metabolism of the vitamin.

Univ. Biochem. Lab. M. A. MUKUNDAN.
Madras-25 (India), T. K. SUNDARAM.
August 1, 1961. E. R. B. SHANMUGASUNDARAM.

1. Hughes, D. E. and Williamson, D. H., *Biochem. J.*, 1953, **55**, 851.
2. Oka, Y., *J. Biochem. (Japan)*, 1954, **41**, 89.
3. Halpern, Y. S. and Grossweiz, N., *Biochem. J.*, 1957, **65**, 716.
4. Sundaram, T. K., Rajagopalan, K. V. and Sarma, P. S., *Ibid.*, 1958, **70**, 196.
5. —, — and —, *Ibid.*, 1960, **74**, 355.
6. Joshi, J. G. and Handler, P., *J. Biol. Chem.*, 1960, **235**, 2981.
7. Johnson, B. C., *Ibid.*, 1945, **159**, 227.
8. Schneider, W. C., *Ibid.*, 1948, **176**, 259.

AMINO-ACID DEFICIENCY OF THE PROTEINS OF LUCERNE LEAF

THE leaves of the lucerne (*Medicago sativa* Linn.) have been shown to have striking supplementary relation to the South Indian rice diet.^{1,2} Further, the proteins of lucerne leaf have definite supplementary relation to rice proteins.³ This appears to be important in view of the fact that Phansalkar *et al.*⁴ did not find significant supplementary relation between rice proteins and four other leaf proteins.

The limiting amino-acid of lucerne-leaf proteins is not clearly established. According to the chemical score method of Block and Mitchell,⁵ lucerne-leaf proteins are most deficient in isoleucine. Biologically, lucerne proteins have been shown to be effectively supplemented with cystine or methionine.⁶⁻⁹ Block and Mitchell⁵ have suggested that this discrepancy may be due to faulty analysis of isoleucine or due to the presence of stems used in the samples tested biologically.

The effect of adding 0.15% isoleucine on the biological value of lucerne-leaf proteins was therefore studied on adult male rats by the Thomas-Mitchell balance sheet method. De-

hydrated lucerne-leaf flour was used as such without attempting to extract the protein. The test diets contained 10% crude protein. In the first period, half the animals received isoleucine supplement and the other half did not. This arrangement was reversed in the second period. The rest of the technique followed was the same as that described by Swaminathan.¹⁰

The biological values obtained for lucerne proteins with and without isoleucine supplementation were 60.8 ± 1.81 and 59.8 ± 1.89 respectively. It would be seen therefore that isoleucine supplementation did not increase the biological value of lucerne proteins. Isoleucine is not therefore the limiting amino-acid of lucerne proteins.

G.S.V.M. Medical College, B. K. SUR.
Kanpur, July 7, 1961. P. P. SINGH.

1. Subrahmanyam, V. and Sur, B. K., *Ind. J. Med. Res.*, 1949, **37**, 319.
2. Sur, B. K. and Subrahmanyam, V., *Curr. Sci.*, 1954, **23**, 188.
3. Sur, K., *Brit. J. Nutr.*, 1961 (in press).
4. Phansalkar, S. V., Ramachandran, M. and Patwardhan, V. N., *Ind. J. Med. Res.*, 1957, **45**, 611.
5. Block, R. J. and Mitchell, H. H., *Nutr. Abst. & Rev.*, 1946, **16**, 249.
6. Kellermann, J. H., *Onderstepoort, J. Vet. Sci.*, 1935, **4**, 437.
7. Smuts, D. B. and Marais, J. S. C., *Ibid.*, 1938, **11**, 399.
8. Marais, J. S. C. and Smuts, D. B., *Ibid.*, 1939, **12**, 369.
9. — and —, *Ibid.*, 1940, **15**, 225.
10. Swaminathan, M., *Ind. J. Med. Res.*, 1937, **24**, 767.

ONE-WAY CROSS-RESISTANCE OF STREPTOMYCIN AND KANAMYCIN

KUNIN AND FINLAND¹ observed little or no cross-resistance between streptomycin and kanamycin working with 210 strains of *Staphylococcus aureus* at Boston City Hospital. The present author, working on the same line, came across one mutated strain of *Staph. aureus* which showed a one-way cross-resistance between streptomycin and kanamycin. In general, it was observed that *Staph. aureus* developed resistance to streptomycin more easily than to kanamycin.

The particular mutated resistant strain was encountered during elaborate studies on staphylococcal resistance to drugs. Apart from other morphological and cultural characteristics of this strain which were similar to the parent, it produced a dark diffusible pigment of about 1 cm. in dia. in nutrient agar within 18 hours. The pigmented zone was very unstable and was lost in the next 48 hours.

The *in vitro* studies of a one-way cross-resistance of this strain was conducted with both streptomycin and kanamycin resistant forms (designated as SR 200, SR 400, SR 600 for streptomycin and KR 20, KR 50, KR 100 for kanamycin resistance at their respective numerical levels in $\mu\text{g./ml.}$) developed from the mutated parent by serial dilution transfers with higher amounts of antibiotic in nutrient broth at pH 7.4. Preliminary observations are presented in Table I.

TABLE I

Growth inhibitions of sensitive and resistant strains of mutated *Staph. aureus* by streptomycin and kanamycin

Strains	Antibiotic treated	Conc. of antibiotic ($\mu\text{g./ml.}$)	Opt. den-sity after 36 hrs.	Zone in mm.
1. <i>S. aureus</i> mutated parent	Streptomycin	50	.164	>25
2. " Kanamycin	"	50	0	18.5
3. SR 200	"	50	0	18.5
4. SR 400	"	50	0	18.5
5. SR 600	"	50	0	18.5
6. KR 20	Streptomycin	50	0	15.3
7. KR 50	"	50	.028	14.6
8. KR 100	"	50	.062	12.8

It was observed that strains resistant to streptomycin was killed by kanamycin, while those resistant to kanamycin showed partial resistance to streptomycin also. The lethality study of kanamycin resistant forms (Fig. 1) revealed that they were partially cross-resistant to streptomycin.

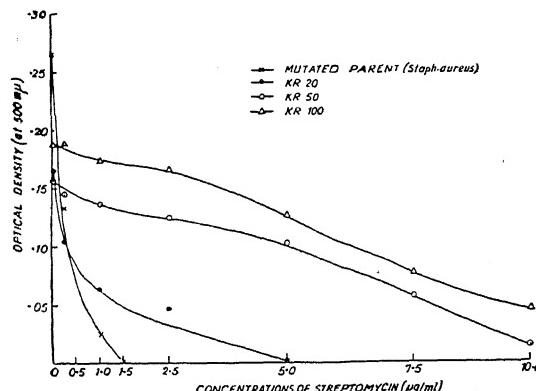


FIG. 1. Growth inhibitions of kanamycin resistant strains of *Staphylococcus aureus* by streptomycin.

Systematic studies on cross-resistance are both of theoretical and practical significance. Bacteria made resistant to a drug developed simultaneously new properties, including sensitivity to other chemotherapeutic agents.² It is rather

early to postulate a theory interpreting this one-way cross-resistance, unless the mode of actions of these drugs are clearly explained.

Kanamycin (KANTREX) was kindly supplied by Bristol Laboratories, Syracuse, N.Y.

Department of Microbiology, P. M. NAHA.*
Bose Institute,
Calcutta-9 (India), July 26, 1961.

* Present Address: Central Rice Research Institute, Cuttack, Orissa, India.

1. Kunin, C. M. and Finland, M., *Ann. N.Y. Acad. Sci.*, 1958, **76**, 42.
2. Szybalski, W. and Bryson, V., *J. Bact.*, 1952, **64**, 489.

DERMATOGLYPHIC STUDY OF TRIBES AND CASTES OF NILGIRI HILLS (MADRAS STATE)

THE dermatoglyphic data from the ten endogamous groups of Nilgiri Hills (Madras) were collected during the months of April to September, 1960, from the three taluqs, namely, Ootacamund, Gudalur and Coonoor and was later analysed by us.* The investigation was conducted in course of an anthropological survey among the tribes of South India on behalf of the Anthropological Survey of India.

TABLE I
Percentage frequency of different fingertip patterns

Groups	Sex	No.	Whorls	Loop Radial	Loop Ulnar	Total Loops	Arch
Paniya	.. M	128	60.6	1.59	36.16	37.75	1.59
do.	.. F	112	53.57	1.61	43.84	45.45	0.98
M. Kurumba	.. M	134	52.83	2.24	44.77	47.01	0.15
do.	.. F	154	45.33	1.95	51.63	53.64	1.04
V. Kurumba	.. M	142	36.84	2.98	57.93	60.91	2.25
do.	.. F	117	36.41	2.39	60.08	62.47	1.11
J. Kurumba	.. M	100	41.60	3.00	55.40	58.40	..
do.	.. F	100	27.00	4.80	6.00	70.80	2.20
Toda	.. M	100	44.60	3.40	49.00	52.40	3.00
do.	.. F	110	48.73	2.18	43.27	45.45	5.82
Kota	.. M	124	42.90	2.10	52.90	55.00	2.10
do.	.. F	100	41.20	1.60	53.00	54.60	4.20
Irula	.. M	170	43.29	3.41	52.00	55.41	1.29
do.	.. F	112	45.00	2.14	50.35	52.49	2.50
Sholaga	.. M	75	51.33	3.33	43.98	47.31	1.33
do.	.. F	88	61.36	0.91	37.73	38.64	..
Badaga	.. M	165	39.57	3.88	54.91	58.79	1.64
do.	.. F	156	42.95	1.67	53.59	55.26	1.79
Moplah	.. M	107	48.41	2.80	47.91	50.71	1.87
do.	.. F	100	44.40	2.80	52.00	55.10	0.50

* The Toda and Kota data were collected by the senior author jointly with Sri. S. K. Basu, while the rest eight groups with Sri. D. B. Sastry.

The data comprise 2,404 individuals (Males—1,255; Females—1,149).

The percentile frequency of the different fingertip patterns and the three important main line formulae on the palms are given in Tables I and II respectively.

TABLE II

Percentile frequency of three important main line formulae

Groups	Sex	11·9·7	9·7·5	7·5·3
Paniya	M	39·13	17·03	22·46
do.	F	37·94	19·39	25·94
M. Kurumba	M	36·03	18·38	28·67
do.	F	25·32	18·83	30·52
V. Kurumba	M	33·09	19·36	15·84
do.	F	35·47	19·23	21·36
J. Kurumba	M	31·00	17·00	31·00
do.	F	19·00	18·00	37·00
Toda	M	68·00	9·00	2·00
do.	F	57·27	1·82	1·82
Kota	M	54·86	9·67	5·64
do.	F	65·00	4·00	3·00
Irula	M	34·11	14·02	24·76
do.	F	34·82	16·96	25·94
Sholaga	M	30·00	20·00	23·33
do.	F	22·91	25·00	33·33
Badaga	M	30·30	15·15	24·24
do.	F	30·43	16·40	29·89
Moplah	M	37·60	14·46	29·25
do.	F	32·71	14·95	26·17

Details of further analysis will be discussed elsewhere.

Anthropological Survey M. R. CHAKRAVARTTI.
of India, D. P. MUKHERJEE.
Calcutta, July 17, 1961.

THE MARINE WOOD-BORER,

XYLOPHAGA FROM BAY OF BENGAL

RECENT studies on the wood-boring organisms in Indian waters have revealed the existence of several species of *Teredo* and *Bankia*,¹ two species of *Matesia*,² two species and a variety of *Sphaeroma*³ and seven species of *Limnoria*.⁴ There is, however, no record of *Xylophaga* from this locality. Concerning these pholads Turner⁵ states that "The genus *Xylophaga* seems to be largely pelagic, occurring mainly in floating and water-logged wood. The genus is worldwide in distribution, but does not occur in sufficient numbers to be of any real economic importance". It was probably because of their habitat that the animals have so far escaped the attention of workers from this country.

During April 1960 we collected a good number of shells of *Xylophaga* from a log of *Tamarix* sp. which was trapped in a trawl-net operating at a depth of 20 fathoms off Puri, Orissa. The wood was fairly heavily infested by this pholad

as well as by *Teredo* (*Zopoteredo*) *trulliformis* Miller, *Sphaeroma terebrans* Bate, *S. annandalei* Stebbing and *S.a.* var. *travancorensis* Pillai.

The shells collected agree very closely with the general characters of the genus. The shell is small, globose, teredo-like in appearance, beaked and widely gaping anteriorly and broadly rounded and closed posteriorly. Beaks truncated at nearly right angles to the anterior margin, extend to more than half the distance to the ventral margin and sculptured with finely denticulated ridges. Ridges on the anterior part of the disc more closely set than on the beak. Umbonal ventral sulcus moderately impressed and bordered by a keel. Umbones prominent and placed near the anterior one-third of the shell. Umbonal reflections narrow, partly covering and appressed to the umbones and free anteriorly. Dorsal plates consist of a divided mesoplax, ear-shaped in appearance and partly covering the umbones. Interior of the shell white and glazed. Posterior adductor muscle scar elongate oval and bounded on its posterior side by a shelf. A ventral adductor muscle scar is apparent. Umbonal ventral sulcus expressed internally as a narrow but prominent and transversely grooved ridge with a small condyle at the ventral margin. Apophysis absent. A chondrophore is present on the left valve. The biggest shell measures 7·8 mm. in length and 7·0 mm. in height.

The soft parts have all disintegrated as the wood was outside sea-water for five days after collection.

The present form resembles *X. mexicana* Dall in the nature of the beak, the muscle scars, the broadly reflected dorsal margin and in the nature of the umbonal ventral sulcus which is narrow and bordered by a keel posteriorly and expressed internally as a pronounced, transversely grooved ridge. Unfortunately the dorsal plates of the above form are not known. According to Turner⁵ *X. mexicana* shares many characters in common with *X. globosa* Sowerby and she opines that they may actually turn out to be the same species. The dorsal plates of the shells collected in our sample are identical with those of *X. globosa*. This and the other characters mentioned would prove beyond doubt that *X. globosa* and *X. mexicana* are, at least, most closely related.

According to Gamble⁶ *Tamarix* sp. from which the shells have been collected is "chiefly found on the banks of streams and on the low lands near rivers". There is therefore little doubt that the timber under question has been washed down the Mahanadi or the Ganges and that the

attack by *Xylophaga* took place in the near vicinity of the area from which it has been recovered. This is also borne out by the fact that the three sphæromids encountered in the wood are characteristic of the estuaries of the Indian rivers and, though not actually recorded, are certain to be found in the estuarine areas of these two rivers.

The present record is interesting since it brings to light the existence of yet another borer *Xylophaga* sp. in Indian waters and from what can be judged from the magnitude of destruction in the sample the animals may prove to be economically important. Whether *Xylophaga* is attacking only flotsam or is also infesting the mangroves and other wooden structures could be ascertained only after a visit to that locality.

We are thankful to the personnel of the C.M.F.R.I., Waltair Unit, for placing the infested log of wood at our disposal and to Dr. A. Purusho ham, Officer-in-Charge, W.P. Branch, Forest Research Institute, Dehra Dun, for kindly arranging for the identification of the timber by the Wood-Anatomy Branch of that Institute.

This work has been carried out with the funds provided by the Forest Research Institute, Dehra Dun, obtained from various sources for the execution of the Scheme on "Protection of Timber against Marine Organisms' Attack".

Dept. of Zoology, P. N. GANAPATI.
Andhra University, M. V. LAKSHMANA RAO.
Waltair, July 29, 1961.

1. Becker, G., *F.A.O. Expert's Report No. 795*, Rome, 1958.
2. Daniel, A. and Srinivasan, V. V., "Occurrence of two wood-boring pholads at Madras," *Curr. Sci.*, 1956, **25**, 259.
3. Krishna Pillai, N., "Wood-boring crustacea of Travancore. I. *Sphæromidae*," *Bull. Centr. Res. Inst.*, Uni., Travancore, Trivandrum, 1955, **4**, 127.
4. Ganapati, P. N. and Lakshmana Rao, M. V., "On some wood-boring crustacea from Andamans," *Curr. Sci.*, 1960, **29**, 275.
5. Turner, R. D., "The family Pholadidae. II. Martesinae, Jouannetinae and Xylophaginæ," *Johnsonia*, 1955, **3** (34), 65.
6. *Gamble, J. S., *A Manual of Indian Timbers*, London, 1922.

* Not referred to in original.

A NOTE ON THE FEEDING MECHANISM OF *X. CHEOPIS*

GORDON AND LUMSDEN,¹ Gordon and Crewe,² Griffith and Gordon,³ Lavoipierre, Dickerson and Gordon⁴ have been working on the feeding mechanism of mosquitoes, tsetse flies, sand-

flies and bugs. The anatomy of the head and the proventriculus in fleas has been worked out in recent times by the Plague Advisory Committee,⁵ Bacot and Martin,⁶ Snodgrass,⁷ Karandikar and Munshi,⁸ Wenk,⁹ and Deoras and Joshee,¹⁰ but there has been no work done on the feeding mechanism in fleas, particularly to know whether it is pool feeding or capillary feeding. The present studies were therefore made to elucidate some aspects of the feeding behaviour of the proboscis of *X. cheopis*, a major vector of Plague in India.

Starved flea was allowed to feed on the ear of a mouse anaesthetised by phenobarbitol sodium. The flea was held in a tube on the ear. Drops of chloroform were released which created an anaesthetic effect on the flea. Partly anaesthetised flea lay limp with its proboscis still stuck in the ear tissue. A portion of the ear with the mouth parts of the flea was cut and fixed in carnoy. It was later processed to get serial sections. Similar preparations were made by cutting the flea behind the head with a sharp blade while it was still feeding on the ear. The results of these studies are given below.

The flea was seen many a time to pierce the skin but did not feed. In such cases it would either completely withdraw the stylets and try a fresh puncture or pull off the stylets to some distance and again thrust the organs to find a proper source of blood. The flea could change the position of stylets inside the tissue even though it kept to the original puncture. Once the puncture was made the stylets penetrated the skin and the labial palps remained bent on the outside. Maxillary lobes also touched the skin of the host. In this position the abdomen of the flea was lifted up.



FIG. 1. Photograph of the head of *X. cheopis* showing stylets in the skin of the mice ear (whole mount preparation).

The feeding of the flea is not interrupted by a mechanical stimulus, unless it has completely fed. The flea seems to be fed even by piercing the stylets half-way in the skin of the host.

Evidence of gross movements of the stylets inside the host tissue were seen in cleared whole mounts. They showed that the stylets may not be forced in perpendicularly but may be bent at any angle even parallel to the skin surface. This showed the flexible nature of the stylets. It was further confirmed in the histological sections of such preparations. These sections showed a longitudinal axis of the fascicle which was confirmed by the observations on the transverse sections of the fascicle in the series. This demonstrates the bending of the fascicle and its flexibility. Such behaviour also tends to show that the flea need not penetrate the mouth parts deep into the skin, but can take the feed only from the superficial layers.

Apart from these bending movements due to the flexible nature of the stylets, it was observed in one case that the stylets turned their axis through an angle of 90°. The anterior face of the stylets was turned to the lateral side. The serial sections of the tissue with the inserted fascicle showed this turning, suggesting that the stylets may also have revolving or screwing type of movement.

The examination of the skin with the fascicle embedded inside has shown that when the fascicle has pierced a capillary it revealed blood in the channel of the fascicle. Blood was not seen inside the food channel when the fascicle was noticed elsewhere in the tissue. This indicated that probably the way in which the flea normally feeds was by "the capillary method".

While studying the method of feeding of *Phlebotomus argentipes* in relation to the transmission of Kala azar, Shortt and Swaminath¹¹ found that the *L. tropica* parasites are introduced by the sand-fly into the tissue and also into the general circulation. Parasites introduced into the general circulation were destroyed, while those at the site of the bite multiplied.

It can thus be surmised that the flexibility of the stylets in the flea *X. cheopis* makes it move in various directions in the tissue in search of a blood capillary for feeding purposes. A contaminated proboscis with *P. pestis* will thus be able to disperse the bacilli in a wider zone. The regurgitation of the block by such fleas directly into the capillary may give a double dose of infection, i.e., locally and in the circulation. Actual transmission and bacteriological examination may confirm this view.

The details of these studies are being published elsewhere.

We are extremely thankful to Dr. H. I. Jhala, Director, Haffkine Institute, for encouraging these studies and to Mr. N. E. Vad for his valuable help from time to time.

Haffkine Institute,
Bombay-12,
August 16, 1961.

P. J. DEORAS.
A. K. JOSHEE.

1. Gordon, R. M. and Lumsden, W. H. R., *Ann. Trop. Med. Parasitol.*, 1939, **33**, 259.
2. — and Crewe, W., *Ibid.*, 1948, **42**, 334.
3. Griffiths, R. B. and Gordon, R. M., *Ibid.*, 1952, **46**, 311.
4. Lavoipierre, M. M. J., Dickerson, G. and Gordon, R. M., *Ibid.*, 1959 **53**, 235.
5. Plague Research Commission, *J. Hyg., Camb.* 1906, **6**, 486.
6. Bacot, A. W. and Martin, C. J., *Ibid.*, 1914, **13**, 423.
7. Snodgrass, R. E., *Smith. Misc. Collections*, 1946, **104**, (18), 1.
8. Karandikar, K. R. and Munshi, D. M., *Jour. Univ. Bombay*, 1949, **18**, 60.
9. Wenk, P., *Zool. Jahrb.*, 1953, **73**, 103.
10. Deoras, P. J. and Joshee, A. K., *Indian Jour. Med. Res.*, 1959, **47**, 261.
11. Shortt, H. E. and Swaminath, C. S., *Ibid.*, 1926, **15**, 827.

VIABILITY OF STORED SEED WHEAT SAFEGUARDED BY SEED DRESSING

IMPORTED wheat grains meant for sowing are usually given a seed-dressing treatment with mercury compounds to guard against the introduction of seed-borne diseases like Bunt. Indeed such a treatment is imperative if the importing country is known to be free from such diseases. But at the present moment there seems to be no information on record as to how long such treated grains could be kept without affecting their viability under Indian conditions. Lack of knowledge on this point was, of late, found to be a great handicap in Bihar, where in recent years wheat cultivation had received a serious set-back due to abnormal floods or drought at the normal sowing period.

This often necessitated a resowing of entire areas, for which tons of seed wheat had to be railed from the Punjab. As, however, the Punjab and Western Uttar Pradesh were known to be subject to various seed-borne diseases, —not so far recorded from Bihar,—all imported grains had to receive a seed-dressing. Owing partly to the higher price of such seed due to the additional cost of transport and seed-dressing, and partly also due to delays in delivery—passing beyond the normal sowing period, a good proportion of the imported stock was left over, which could not be used for

consumption either by man or cattle, owing to the contamination of mercury compounds.

In these circumstances, in the absence of data on the limit of viability of treated seeds, the following experiments were started to get reliable data in the matter.

The usual method of seed-dressing is by the application to seed-grains of AGROSAN-GN, a ready-made mercury compound, marketed in India by the Imperial Chemical Industries Ltd., at the rate of 4 oz. (0.117 Kg.) to a maund (37 Kilos) of grain.

Experiments were devised using healthy wheat seed of NP 52 variety stored in small jute bags of the type generally used by Indian stockists, with a capacity of holding 10 seers (9 kilos) of grain, as units for observation. The chemical was applied to seed by using a seed-dressing drum and the treated seed was kept in a set of 4 small bags, which were duly labelled and closed by tying them up with string. As control, another set of 4 bags of untreated seed was kept under identical conditions in the laboratory. Seeds showing less than 90% germination were not used for the experiment.

During the first year, fortnightly examinations were made by taking 25 grains at random from each bag for testing their germination capacity, and the result recorded. During the second year, a fresh set of experiments was started, but it was felt that a three-monthly test would equally serve the purpose of the experiments. The results of the examinations made are given in Table I.

TABLE I

Showing the comparative results of germination tests carried out on treated and untreated seed during two years

Period	Year 1957-58		Year 1958-59	
	Treated %	Untreated %	Treated %	Untreated %
1 Oct.-Dec. ..	100	99.5	99.5	99.5
2 Jan.-March ..	98.3	97.3	98.5	97
3 April-June ..	96.3	98.7	97	96
4 July-Sept. ..	92.6	80.8	..	..
As examined on 25 Oct. 1958	88.5	33.5	As examined on 20 Oct. 1959	
			94.5	52.5

It may be seen from the above data that in the case of the untreated seed, there had been a sharp fall in germination capacity at the end of the monsoon period, whereas there

was very little in the case of the treated grains. These trials have clearly demonstrated that treated seed can be kept with impunity in store for a year without loss of viability, which was all that these experiments were designed to show. It is regretted that the scope of these studies could not be extended further.

This work was taken up at the personal suggestion of the Hon'ble Minister of Agriculture, Shri B. C. Patel, to whom the writer is grateful. He also wishes to record his thankfulness to Shri Leslie Jones for assistance given in the germination counts at the Agricultural Research Institute, Patna.

Kanke, Ranchi,
August, 1961.

A. C. SEN.*

* Formerly Director, Agricultural Research Institute, Patna (now at Agricultural College, Kanke, Ranchi, Bihar).

A LOCALISED CHLOROPHYLL DEFICIENCY ASSOCIATED WITH MALE STERILITY IN *NICOTIANA TABACUM* L.

SPONTANEOUS occurrence of male sterility controlled by single or duplicate factors is known only in a few cases in *Nicotiana tabacum* (Raeber and Bolton, 1955, and Bhat and Krishnamoorthi, 1956). Other teratological modifications of the stamens and consequent male sterility controlled by a single gene are also reported in X-ray populations of the same species (Goodspeed, 1930).

During the screening of the irradiated material of flue-cured varieties of *Nicotiana tabacum* for viable mutations after seed treatment with thermal neutrons (flux 1×10^{12} to 5×10^{13} N.sec.cm.⁻²), male sterile plants appeared in the n_2 generation in five different lines.

Three varieties, viz., Hicks, Delcrest and Chatham, were irradiated at the levels mentioned above. But male sterile plants appeared only in Hicks and at the dose 1×10^{12} N.(cm.)². Several plants had been selfed in the n_1 generation both in the control and irradiated populations. Of them, 10 lines were raised in each category. Only 5 of the 10 lines in the irradiated population segregated for male sterility.

Two categories of male steriles were found. In both cases the anthers were rudimentary.

In one there was development of appendages with no sporogenous tissue; in this case seed set could be obtained by pollinating with normals indicating that the female gametes were functioning normally.

In the second category, appendages were absent, the stigma was yellow and the style was very short, 5-6 mm., compared to over 40 mm. in the normal plants. These plants were also characterised by condensed panicles, clustering of flowers and cleistogamy (Figs. 1 and 2c, d). The corolla was whitish and the

Among the five lines three segregated only for male sterility, one for 'yellow stigma' only and one for both 'male sterility' and 'yellow stigma'. In the 'yellow stigma' segregants none were present with appendages on the anthers similar to those found in the first category of male sterility. The data suggest that



FIG. 1. Panicle of the 'yellow stigma' mutant showing crowding and cleistogamy of flowers.

younger leaves below the peduncle turned yellowish-green with the onset of reproduction, while the lower leaves remained normal green. The stamens were reduced in size and obliterated. Pollen was absent in all cases except in one of the flowers which had nearly 10% stainable pollen. Pollination with abundant pollen from the normal sibs failed to give any seed set indicating female sterility also.

The n_1 plants from whose progenies these two types of male steriles were obtained were phenotypically normal and the F_1 between the first category of male sterile mutant and the normal was completely fertile. This character can therefore be considered to be recessive to normal. The distribution of the different categories of mutants in the n_1 and n_2 generations is given in Tables I and II. The two classes of mutants are called "male sterile" and "yellow stigma" respectively for brevity.

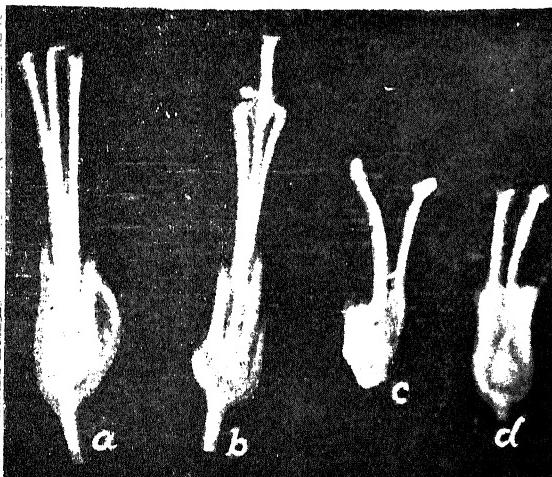


FIG. 2. Flowers of a, normal; b, males sterile; c, yellow stigma mutant. Note the dwarf style in d.

the first case of male sterility is due to duplicate recessive factors. Line-1 gave simplex segregation suggesting that it is homozygous for one of the recessive genes. The 'yellow stigma' character also appears to be due to duplicate recessive factors. To ascertain whether the male sterility in 'yellow stigma' plants is due to pleiotropic effect of the genes for chlorophyll deficiency or due to close linkage with genes for male sterility, test for linkage was carried out by Fisher's scoring method. The test confirmed that linkage was not involved. Therefore the male sterility in the 'yellow stigma' is due to the pleiotropic effect of the genes for chlorophyll deficiency and appears to be distinctly different from the male sterility with the anther appendages encountered in the same population. These two mutants appeared only in Hicks but not in the other varieties (Table II). Such a specific response by a variety to a certain dose

TABLE I
Distribution of mutant categories in the n_1 and n_2 generations

Gene- ration	Variety	Total plants studied	Chlorophyll mutants (seedlings)		Leaf modifications No. of plants different in leaf characters from normal	Floral teratology			Sterile mutants		
			Normal	Albina		Split flr.	Caly- cina	Cleisto- gamous	Pollen abortion over 30%	Male sterile anthers	Com- plete sterility
n_1	Hicks	480	480	..	14	1	1	1	136	1	..
	Delcrest	420	420	..	6	..	..	..	75	..	..
	Chatham	270	270	..	1	..	..	..	69	..	..
n_2	Hicks	800	540	168	2	..	..	..	20	185	101
	(separate scoring)									(Normal)	(Normal)
										28	8
										Male sterile	Yellow stigma
	Delcrest	900	..	..	i	..	..	..	16	..	..
	Chatham	900	..	..	..	..	..	..	..	..	..

TABLE II
Distribution of 'male sterile' and 'yellow stigma' mutants in the n_2 generation

Sl. No.	Lines	Total No. of plants	Normal	'Male sterile'	'Yellow stigma'	X^2
1	7-44 (3 : 1)	55	40	15	..	0.1514
2	23- 8 (15 : 1)	48	43	5	..	0.893
3	20-32 (15 : 1)	54	51	3	..	0.0743
4	23-16 (15 : 1)	56	50	..	6	1.167
5	23-42	58	51	5	2	2.157

indicates that the residual genotype has considerable influence on the mutability of the concerned loci. It is interesting that both these cases are due to duplicate factors while in X-rayed population studied by previous workers, male sterility was a simple recessive. The denser ionizing radiation of neutrons is responsible for simultaneously knocking out the two loci concerned and the higher viability of the neutron-treated material compared to X-rayed material has permitted the detection of the mutants which would have been lost due to the drastic side-effects of the X-rays.

Studies are under way to ascertain whether the male sterility genes are iso-allelic with other male sterile lines maintained at this Institute. The genes for yellow stigma were designated as ys_1 and ys_2 . These are different from the stigmatoid gene isolated by Goodspeed (1930). The manifold effects associated with the dwarfing of stigma without any reduction in the vegetative plant organs is unique in this case.

1. Bhat, N. R. and Krishnamoorthi, T., *Curr. Sci.*, 1956, **25**, 297.
2. Goodspeed, T. H., *Univ. Calif. Pub. Bot.*, 1930, **11**, 285.
3. Raeber, J. G. and Bolton, A., *Nature*, 1955, **176**, 314.

ON THE MORPHOLOGY OF THE POLLEN GRAINS OF THE TWO SPECIES OF *CUCURBITA* L.

In an intensive study of the pollen morphology of *Cucurbita moschata* and *C. pepo* the following pollen characters were noted :—

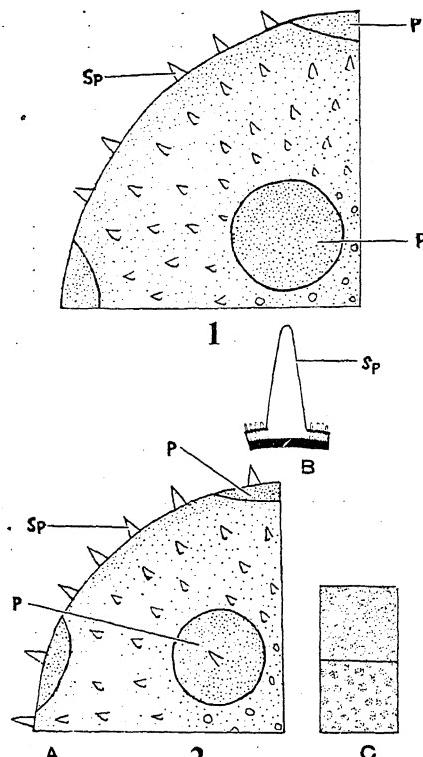
C. moschata Duch. ex. POIR (Fig. 1)—Panporate, spheroidal (average diameter $107\ \mu$, exclusive of the excrescences). Pores circular (diameter $32\ \mu$). Interporal distance $49\ \mu$. Exine $1.4\ \mu$ thick (exclusive of excrescences). Ectine thicker than endine, spinate in a majority of grains. Interporal area provided with minute projections (LO). Variations in different morphological structures have been studied as follows :

- (i) Size varies from $85-193\ \mu$. Grains having a size of $95\ \mu$ form 1%, $193\ \mu$ form the maximum of 13% and the "giant grains" having a size of $304\ \mu$ form 1%. Double grains¹ measure $231-63\ \mu$. Average size

of unacetolysed grains is 126μ (range; 91 – 210μ).

(ii) Apertures—Rarely 3-Zonocolporate, 3-Syncolpate or 3-Zoniporate, along the panporate grains.

(iii) Excrescences—Various types of excrescences forming different percentages are as follows: (a) spinate (with pointed ends; 40%); (b) clavate (17%); (c) spinate (with blunt ends 15%); (d) verrucate (14%); (e) baculate (8%); (f) clavate + spinate (spines with blunt ends 6%). Middle regions in the double grains are unornamented.^{2,3}



FIGS. 1-2. Fig. 1. Palynogram of *C. moschata*; General surface of the quarter of a grain shown. Fig. 2. Palynogram of *C. pepo*. A—General surface (quarter of a grain shown). B—Strata. C—LO pattern of inter-spiral area. P = pore; Sp = spine. 1 & 2, $\times 500$; B & C, $\times 2,000$.

C. pepo D.C. (Fig. 2)—Pamporate, spherodial (diameter 140μ ; range 123 – 201μ). Pores circular (diameter 25μ), tenuimarginate, pore membrane-bearing spines. Interporal distance 53μ . Exine 1μ thick, spinate (spine ends acute; 7μ long; basal diameter 2.8μ). Interporal distance 14μ . Interporal area bears profuse, rod-like projections.

The large variations in size and apertural characters noted in the above grains are probably the result of polyploidy and hybridization. Frequency of the morphological features may constitute a varietal character. A fuller paper will be published elsewhere.

I am grateful to Dr. A. R. Rao for suggesting this polynological problem and guiding me, and to Dr. P. K. K. Nair for many valuable suggestions.

Botany Department, MISS PRITI AWASTHI,
Lucknow University,
Lucknow, April 27, 1961.

1. Sampath, S. and Ramanathan, K., *J. Indian bot. Soc.*, 1951, **37**, 220.
2. Nair, P. K. K., "Pollen grains of Indian plants," *Bull. Nat. Botanic Gardens*, Lucknow, 1961, **1**, 53.
3. Wodehouse, R. P., *Pollen Grains*, McGraw-Hill Book Co., New York, 1935.
4. Nair, P. K. K., *J. Indian bot. Soc.*, 1960, **39**, 373.

A NEW SPECIES OF *ALTERNARIA* FROM BOMBAY-MAHARASHTRA-II

In the course of his investigation into the fungus genus *Alternaria* in the Bombay-Maharashtra, the writer encountered vines of *Dioscorea alata* L. growing at a local Agriculture Farm, Poona, showing severe and extensive blighting. The necrotic areas invariably yielded a pure culture of an *Alternaria* species. A careful search of the available literature showed that no species of *Alternaria* has been previously reported, on this host. The fungus thus appeared to be new to science and is presented here as new species with Latin diagnosis.

Alternaria dioscoreae VASANT RAO, SPEC. NOV.

Infectionis maculae epiphyllæ, dispersæ, irregulariter ovoideæ, fusce brunneæ, 15×9 mm. Conidiophori singuli vel fasciculati, emergentes per stomata, epiphylli æque ac hypopylli, erecti, plus minusve curvati, semel vel bis septati, non-constricti, basi bulbosa, apice rotundato, sœpe una cicatrice terminali præsenti, 25.2 – 92.4×4.2 – 5.2 μ .

Conidia copiosa in planta hospite, breviter catenulata (2-3), alte brunnea, obovata vel obclavata, rotundata ad basim, fastigata ad apicem in rostrum non septatum ornata septis 4-7 transversis, 2-3 longitudinalibus, septis obliquis raris, constricta ad septa, 48.3 – 79.8×12.5 – 14.5μ rostro inclusio, $35.7 \times 13\mu$ absque rostro.

In foliis et surculis viventibus *Dioscoreæ alatae* Linn., mense septembri anni 1960, ad Poona, in India; leg. Vasant Rao.

Typi harum specierum positi sunt in Herb. Crypt. Indiæ Orient. ad New Delhi et in Commonw. Mycol. Inst. in Horto Kewensi, in Anglia.

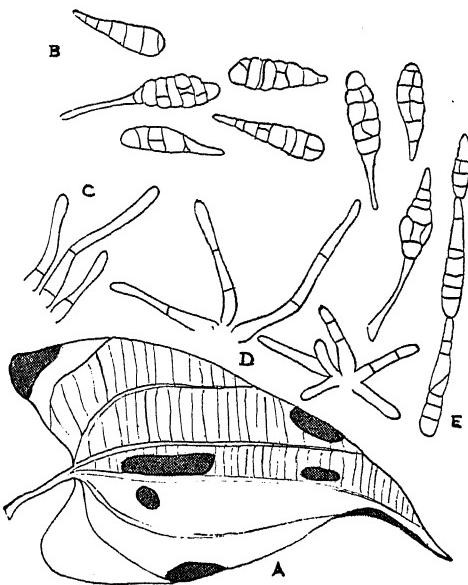


FIG. 1. Alternaria blight of *Dioscorea alata* L. A. habit ($\frac{1}{2}$ Natural size), B. Conidia, C. Conidiophores, D. Branched conidiophores, E. Catenulate formation of conidia, All, $\times 220$.

Alternaria dioscorii SP. NOV. VASANT RAO (FIG. 1)

Infection spots, epiphyllous, scattered irregularly ovoid, and dark-brown in colour, 15×9 mm.

Conidiophores, single or in fascicles, emerging through stomata, epi as well as hypophyllous, erect, more or less bent, 1-2 septate, not constricted, bulbous at base and rounded at apex, often with a single terminal scar, $25.2-92.4 \times 4.2-5.2 \mu$. Conidia abundant on host in short chains (2 to 3), deep-brown, obovate to obclavate, rounded at base, tapering towards apex into a non-septate beak, with 4-7 cross septa, 2-3 longitudinal septa, oblique septa rare, constricted at septa, $48.3-79.8 \times 12.5-14.5 \mu$ (with beak), $35.7 \times 13 \mu$ (without beak).

In living leaves and shoots of *Dioscorea alata* L. September 1960, Poona, India, Collected by Vasant Rao.

The type specimen has been deposited at the Herbaria Cryptogamia Orientalis, New Delhi, India, and Commonwealth Mycological Institute, Kew, England.

Further work on the etiology of this fungus is in progress and will be reported in due course.

The writer is grateful to Prof. M. N. Kamat for his deep interest, encouragement and guidance, to the Director, M.A.C.S., Poona 4, for facilities at the Institute and to Prof. H. Santapau, Chief Botanist, Botanical Survey of India, Calcutta, for Latin rendering of the description of the new species. He is also grateful to I.C.A.R., New Delhi, for the award of a research scholarship.

M.A.C.S., VASANT GURUNATH RAO.
Poona-4, September 10, 1961.

STRUCTURE AND ONTOGENY OF EPIDERMAL APPENDAGES ON THE FLORAL ORGANS OF *OCIMUM BASILICUM* L.

THE taxonomic significance of hairs and glands has been emphasized by several workers from time to time. Bachmann¹ investigated the structure of hairs of 34 families of angiosperms and presented a key for their identification. Cooper² studied their structure and development in the Eleagnacæ. Murthy³ described the glandular hairs in *Orthosiphon stamineus* and recently Carlquist²⁻⁴ gave an account of their development in some members of the Compositæ. However, our knowledge regarding their ontogeny is still meagre.

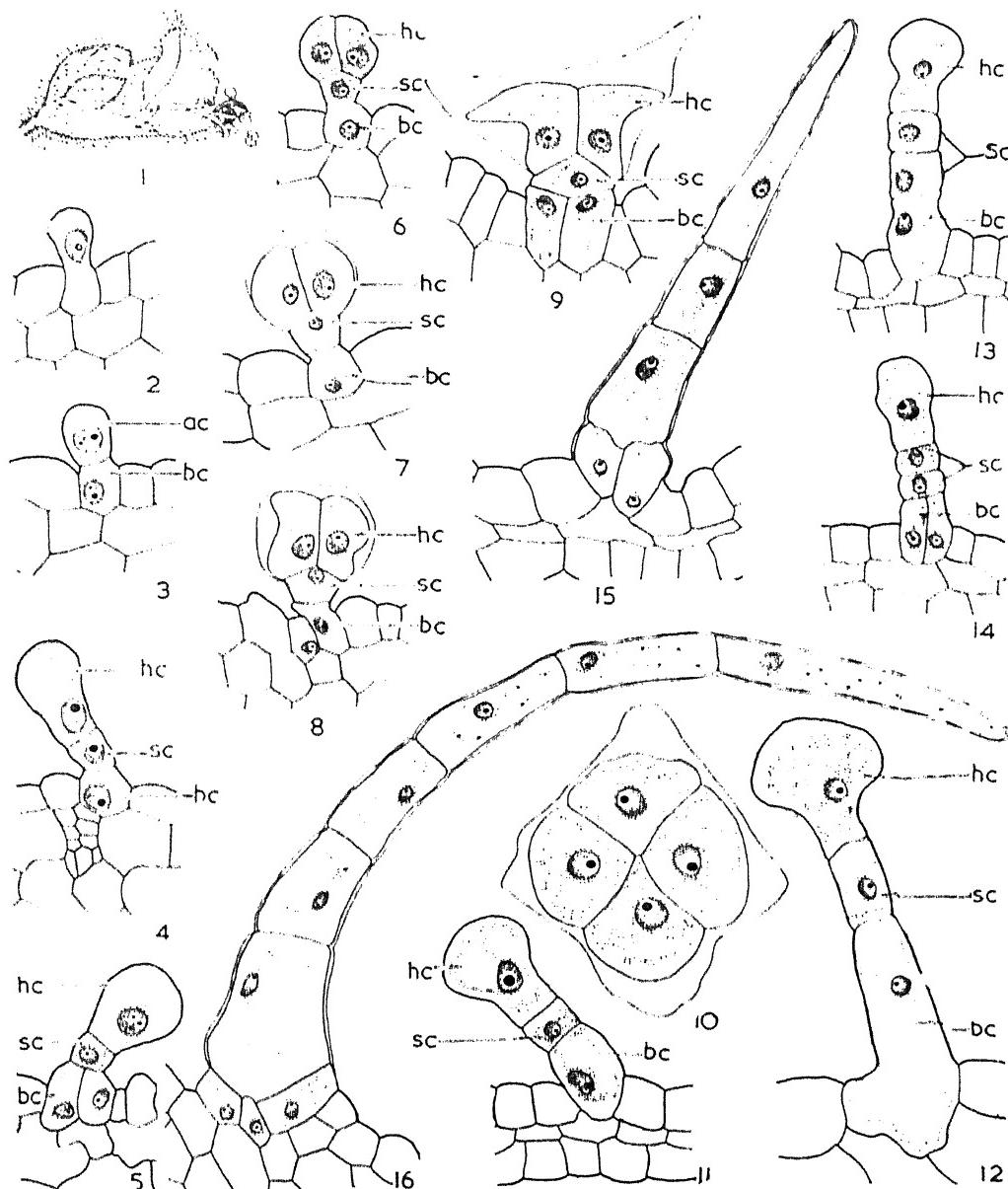
Various types of hairs and glands occur in the family Labiatæ and serve as valuable characters for the identification of the genera and species. The volatile and ethereal oils which give the plants of this family their characteristic aroma, are secretions of these glands. The present paper deals with the structure and development of the glands and trichomes of *Ocimum basilicum* collected from the Delhi University Botanical Gardens. The buds and flowers were fixed in formalin-acetic-alcohol and usual methods of dehydration, infiltration and embedding were followed. Sections were cut at a thickness of 8-12 microns and stained with safranin and fast green.

Metcalfe and Chalk⁶ have classified the glandular hairs of the Labiatæ into five different types. In *Ocimum* only one type of gland is reported by them. On the contrary, I have observed three types of multicellular epidermal hairs on the flowers of *O. basilicum* (Fig. 1). These are: (a) multicellular glands with four-celled head; (b) multicellular glands with one-celled head (this is the type reported by Metcalfe and Chalk⁶); and (c) simple, non-glandular, uniseriate, multicellular hairs.

The hair originates from a single cell of the epidermis. In earlier stages of development,

all the cells of the epidermis look alike. Soon one of them becomes distinguishable from the rest by its larger size, dense cytoplasm and conspicuous nucleus. This cell functions as the hair initial. It becomes papillate and vacuolated (Fig. 2), and divides by a transverse septum

resulting in the formation of an apical (*ac*) and a basal cell (*bc*, Fig. 3). The former has denser cytoplasm and a comparatively large nucleus. It divides periclinally to form two cells of which the upper develops into the head of the gland and lower forms its stalk (Fig. 4). This is fol-



FIGS. 1-16. Glands and trichomes. Fig. 1. Flower bearing glands and trichomes. Fig. 2. Papillate epidermal hair initial. Figs. 3-4. Two- and three-celled stages. Figs. 5-6. Four-celled hairs; in Fig. 5 the basal cell has divided vertically. Figs. 7-9. Hairs with distended cuticle. Fig. 10. T.s. through the head of a glandular hair. Figs. 11-14. Stages in the development of glandular hair with single-celled capitate head. Figs. 15-16. Uniseriate multicellular trichomes.

Fig. 1, $\times 8$; Figs. 2-16, $\times 970$. (*ac*, apical cell; *bc*, basal cell; *hc*, head cell; *sc*, stalk cell).

contrast to Murthy's⁷ observations on *Orthosiphon stamineous* where the hair initial divides transversely into a head and a stalk cell. The latter again divides periclinally to form the middle and the basal cells; the middle cell forming the stalk of the gland.

Further development differs in the various types of hairs. In the first or type A, at the three-celled stage, the head cell (*hc*) becomes capitate (Fig. 5) and divides anteclinally to form two cells (Fig. 6). Another division results in the formation of four cells (Fig. 10). The stalk cell (*sc*) remains undivided and pushes into the base of the glandular head whereas the basal cell undergoes a vertical division and becomes two-celled (Fig. 8). Rarely the basal cell may remain undivided. The metabolic by-products secreted by the glands accumulate between the cell-wall of the head and the cuticle which becomes distended at the 2-celled stage of the head (Figs. 7-9). Due to the pressure exerted by these, the cuticle bursts and the secretion escapes into the atmosphere producing the characteristic aroma.

In type B there is slight elongation of all the cells at the three-celled stage. Subsequently the head cell assumes a capitate form (Figs. 11, 12); the stalk cell divides transversely to form two cells (Fig. 13); and the basal cell undergoes a vertical division (Fig. 14). This results in a multicellular gland with one-celled head, two-celled stalk and a uni- or bi-celled base.

In the third type C, soon after the two-celled stage, the upper cell elongates and assumes a tapering appearance. It undergoes several transverse divisions resulting in the formation of a unisexual six- to eight-celled, heavily cutinized, trichome (Figs. 15, 16). Further divisions in the lower cell form a two- or three-celled base.

It gives me great pleasure to express my gratitude to Dr. R. N. Kapil and Professor P. Maheshwari for their guidance and constant encouragement during the course of this investigation.

Department of Botany, SNEH LATA MATHUR.
University of Delhi,
Delhi-6, September 16, 1961.

1. *Bachmann, O., *Flora*, 1886, **69**, 387; 1886, **69**, 403; 1886, **69**, 428.
2. Carlquist, S., *Amer. J. Bot.*, 1958, **45**, 675.
3. —, *Ibid.*, 1959 a, **46**, 70.
4. —, *Ibid.* 1959 b, **46**, 300.
5. Cooper, D. C., *Ibid.*, 1932, **19**, 423.
6. Metcalfe, C. R. and Chalk, L., *Anatomy of Dicotyledons*, Clarendon Press, Oxford, 1950.
7. Murthy, S. N., *Curr. Sci.*, 1941, **10**, 534.

* Not seen in original.

RESPONSE OF HYBRID MAIZE TO ZINC FERTILIZATION

Of all the essential micronutrient elements, maize has the highest requirement for zinc. Very encouraging results have been reported from various parts of the world, regarding the crop responses to zinc fertilization.^{1,2,4-6} Light soils particularly, are known to be deficient in zinc. Zinc content of the light alluvial soils of northern India, as judged from the available data, also appears to be low: total zinc content of Panjab soils has been reported to be 55 p.p.m.,⁵ while the soils of I.A.R.I. farm have been found to contain only 20 p.p.m.³. These figures are evidently far below the average figure of 80 p.p.m. of total zinc reported to be present in the lithosphere.⁷

With the prospects of introduction of hybrid maize for general cultivation in this country in the near future, investigations on the nutrition of hybrid maize have been initiated at the Division of Agronomy, I.A.R.I., New Delhi. The quick growing nature of this crop, the high nutrient uptake in general, and the high zinc requirement in particular, together with the evidence of low content of zinc in the soils of I.A.R.I. farm cited above prompted the initiation of investigations on the zinc fertilization of hybrid maize.

The present investigation was, therefore, planned in Kharif 1960 to study the response of hybrid maize variety Texas 26, to the application of zinc and a number of other micronutrients with and without a basal dose of NPK fertilizers. In the same experiment, seed, soil and spray methods of applications were also tried. There were, in all, 24 treatment combinations which were replicated four times in a Randomised Block Design. However, in this brief note, only the treatments relevant to the assessment of the response of Texas 26 to zinc fertilization have been given in column No. 2 of Table I. The standard error and the L.S.D. used to test the significance of differences between these various treatment combinations are the same as obtained from the analysis of the entire experimental data.

RESULTS

The data on the yield of total dry matter and grain yield of hybrid maize, are presented in Table I.

It is evident from the data that responses to micronutrients were obtained only in the presence of NPK. Highly significant increase in dry matter was obtained when zinc was applied to soil in conjunction with NPK as

compared to NPK alone. Soil application of all the essential micronutrients used, did not give any additional increase over the treatment when zinc was used alone. Seed-soaking treatment with zinc and other micronutrients proved to be the best in improving dry matter yield by about 20.2% over NPK.

TABLE I
Effect of zinc fertilization on the total dry matter and grain yield of Texas 26

S. No.	Treatment	Total dry matter yield tons/hect.	Grain yield kg./hect.
1	Control (No NPK) ..	3.775	539.81
2	Zn + other* micronutrients in soil (No NPK)	3.866	458.53
3	Zn + other micronutrients as spray (No NPK)	2.757	282.83
4	Zn + other micronutrients as seed soaking (No NPK)	3.218	353.38
5	NPK (No micronutrients)	6.869	1714.87
6	NPK + Zn in soil	7.968†	2140.47
7	NPK + Zn as spray	5.976	1498.20
8	NPK + Zn + other micronutrients in soil	7.430‡	2257.38‡
9	NPK + Zn + other micronutrients as spray	6.566	1380.48
10	NPK + Zn + other micronutrients as seed soaking	8.260†	2232.91
S.E Dm.		±0.253	±272.09
L.S.D. (P=0.05)		0.500	537.47
L.S.D. (P=0.01)		0.667	..

Note.—The doses of $ZnSO_4 \cdot 7H_2O$, used in soil, spray and seedsoaking, were 5.60, 1.121 and 0.026 kg/hectare respectively.

* Other micronutrients applied were Cu, Mn, Fe, B and Mo. Mg a macronutrient was also included.

† Significant at 1%.

‡ Significant at 5%.

Soil application of zinc increased the grain yield. The increase was, however, more when other micronutrients were also applied along with zinc. A significant increase in yield of 32.28% was obtained in the latter case. Seed soaking with zinc and other micronutrients, closely approached the soil application in affecting yield of grain but just missed the level of significance as in the case of zinc applied alone in soil. High coefficient of variation (27.25%) obtained in the present case, is largely responsible for this.

DISCUSSION AND CONCLUSIONS

From the results, cited above, it may be concluded that there was a distinct increase in the total dry matter per acre due to zinc fertilization. Significant increases were likewise obtained in grain yield per acre when zinc was applied in conjunction with other micronutrients.

The facts that none of the other micronutrients used in the experiment showed any distinct increase in grain yield individually, and that the increase resulting from zinc application alone missed significance by a very narrow margin, indicate that the major share of the increase in yield due to combination of all micronutrients was due to zinc or at best to its complementary effects with other micronutrients. However, this point needs to be investigated further. The results are evidently of use to all those who are interested in the realisation of maximum yield potential of crops in general and hybrid maize in particular, through balanced nutrition. There are possibilities of increasing the yield of hybrid maize as much as 20 to 30% with zinc fertilization alone as well as with the application of zinc in combination with other micronutrients, over and above the increase obtained with the application of the three major nutrients, NPK.

Division of Agronomy,
Indian Agricultural
Research Institute,
New Delhi-12, July 24, 1961.

L. R. AHUJA.
O. P. GAUTAM.

- Barnette, R. M. and Warner, J. D., *Soil Sci.*, 1935, 39, 149.
- Chilean Nitrate Educational Bureau Bibliography on Minor Elements, 1948/55.
- Datta Biswas, N. R. and Dakshnimurti, C., *Ind. Jour. Agro.*, 1958, 3 (1), 48.
- Grunes, D. L. et al., *Agro. J.*, 1961, 53 (2), 69.
- Kanwar, J. S. and Randhawa, N. S., *Simla Seminar on "Recent Advances in Agronomy and Soil Science,"* I.C.A.R., 1959.
- Sadaphal, M. N. and Das, N. B., *Sci. and Cult.*, 1956, 32, 233.
- Swaine, D. J., *Commonwealth bur. Soil Science Tech. Commun.*, 48, 1950.

A NOTE ON VEGETATIVE PROPAGATION OF CULTIVATED RICE

In the cultivated varieties of rice so far examined rudimentary buds are present in the axils of leaves especially at the lower nodes. A thin membrane, H-shaped in cross-section is found between the culm and the buds in the leaf axils. The buds as well as the prophyllum situated at different nodes exist in various stages of development, longer at the lowest nodes and shorter at the upper nodes. Minute projections of root primordia are also faintly discernible at times at the base of nodes and with adequate water-supply these root primordia at the lower nodes may grow and develop into roots in some varieties. Such formation of roots at nodes was very marked in PTB. 10. in contrast to other varieties under trial at the Rice Research Station, Moncompu. Normally, the rudimentary

due to the axil of leaves above the tillering zone did not develop. But in some varieties like 'Golamgare', the axillary buds emerge out and form stumps at higher nodes. Tiller may also arise from buds at higher nodes when overaged seedlings are transplanted or when the crop lodges or when the main tiller is damaged either by gall fly, *Pachydiplodia oryzinae* (W.M.) or by stem borer, *Nebasubrachys incertus* Wall.

New shoots emerging from rice stubbles after harvest ratooning is a common feature. These ultimately produce short panicles bearing a few spikelets, probably due to the limited availability of nutrients and moisture. Different varieties of rice behave differently in the habit of ratooning and it is the axillary buds developed at the node of the stubble which grow into tillers.

The above observations as well as the ability of stem cutting of a type of perennial floating wild rice, in which the development of bud is much pronounced made the author feel that it might be possible to propagate some of the cultivated rices by stem cutting. Observations resulting from a preliminary study are presented below.

Stems showing no decay and with fully matured earheads from two varieties, PTH 16, a local improved early maturing variety, and P.H. 37, a fully pigmented introduced variety from Bihar, were collected separately. These were cut into pieces, with one node in each piece. Cuttings from the portion of the culm above water level were alone taken for clamping as it was found that the buds at the lowermost nodes usually exhibited signs of decay. The leaf sheath enclosing the bud was green and hard in some of the cuttings from the higher region of the stem. In such cases the sheath was split open gently, which facilitated the emergence of buds. The cuttings were then planted either vertically or horizontally in pots filled with river sand and watered daily. In vertical planting the nodes were placed partially under the soil.

Roots were seen emerging from the base of the nodes on the second day onwards, when no symptoms of growth of the bud could be noticed. Gradually swelling and elongation of the buds and splitting of the leaf sheath were noticeable a week after planting and the buds emerged after a fortnight. Whenever the development of buds was advanced at the time of planting, these emerged earlier and roots arose from the base of the bud later and these ultimately grew into normal plants (Fig. 1). Too much of water completely decayed the cuttings. Seed-

lings of these two varieties, thus raised, were transplanted in pots which eventually produced panicles. In PTH 16 the panicle emerged a month after transplanting and these were not very long. But in the other variety, P.H. 37, the panicle emerged after two and a half months.

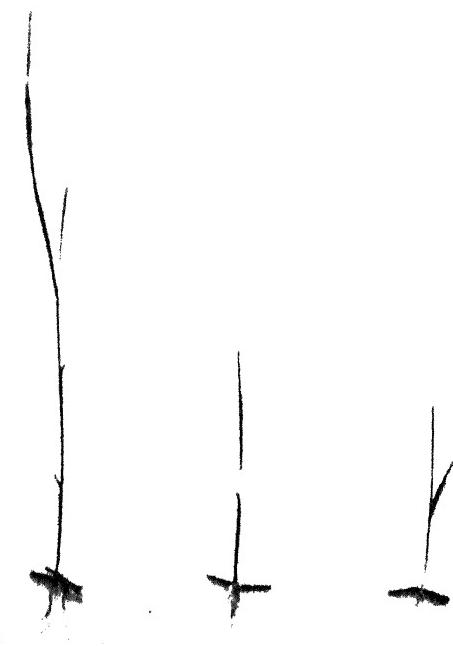


FIG. 1

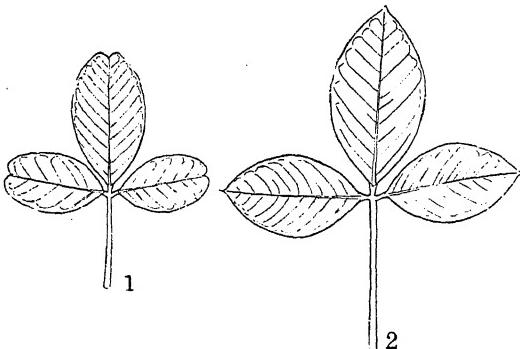
An interesting possibility thus exists to obtain larger number of plants by stem cutting than by planting stubbles to carry forward hybrids and other valuable material to the next season and for obtaining a large quantity of seeds. Whether all the cultivated varieties of rice can be propagated by stem cutting; or whether such a vegetative propagation is practicable on a large scale are matters that require further studies.

The authors are working in a scheme partly financed by the Indian Council of Agricultural Research and help from the Council is duly acknowledged.

1. Ramiah, K., Rice Breeding and Genetics—Scientific Monograph No. 19, I.C.A.R., New Delhi, 1950.
2. Israel, P. and Veda Moorthy, G., Curr Sci., 1958, 309.
3. Reddy, V. R. and Pawar, M. S., Andhra Agric. J., 1959, 6(2), 70.

INHERITANCE OF THE RETULE (NOTCHED) LEAF APEX IN A CROSS BETWEEN *CROTALARIA STRIATA* DC. AND *C. MUCRONATA* DESV.

Crotalaria striata, a promising green manure plant in South Indian plantations is often referred to as *C. brownii* Bert, *C. saltiana* Andr., and *C. mucronata*.¹ In order to solve the nomenclatural confusion, morphological and cytogenetical observations are in progress at this Institute. In the present note a brief account on the inheritance of leaf apex in reciprocal crosses between *C. striata* and *C. mucronata* is presented.



FIGS. 1-2. Fig. 1. Leaf of *C. mucronata*. Fig. 2. Leaf of *C. striata*.

TABLE I

Inheritance of leaf apex in reciprocal crosses between *Crotalaria striata* and *C. mucronata*

Cross No.	Female parent	Male parent	<i>F</i> ₁	<i>F</i> ₂		
				No. of plants	Acute leaf apex	Retule leaf apex
3	<i>C. striata</i>	.. <i>C. mucronata</i>	Retule leaf apex	72	240	
4	Expected on 3 : 1 Ratio	..	..	78	234	
	<i>C. mucronata</i>	<i>C. striata</i>	Retule leaf apex	34	138	
	Expected on 3 : 1 Ratio	..	..	43	129	
	X ² for cross No. 3 = 0.572					
	X ² for cross No. 4 = 2.511					

Leaf apex is 'acute' in *Crotalaria striata* and 'retule' with a shallow notch in *C. mucronata* (Fig. 1). Reciprocal crosses between these two plants were effected. The hybrid generation in both the crosses exhibited the retule apex indicating the dominant nature of this character. The *F*₂ population was raised and individual plants were studied for leaf apex character. The data on appearance of *F*₁ and segregation in *F*₂ generations are given in Table I.

From Table I it may be concluded that the leaf apex character is controlled by a single gene as exhibited by the monohybrid ratio.

We are thankful to Shri B. Venkoba Rao, Principal, for providing facilities and to Dr. H. C. Govindu, Plant Pathologist (Research and Education), for help in preparation of the manuscript.

Division of Botany, S. R. CHANDRASEKHARIAH. Agric. College and N. S. PARAMESWAR.

Research Institute,
Hebbal, Bangalore-6,
May 2, 1961.

1. *The Wealth of India* (Raw materials), C.S.I.R., New Delhi, 1950.
2. Kempenna, C. and Chandrasekhariah, S. R., *The Mysore Agric. Jour.*, 1960, 35 (1), 9.

NUCLEOLAR NUMBER AND POLYPLOIDY LEVEL

THE number of nucleoli per nucleus has been considered as a fairly reliable criterion to indicate the level of polyploidy in a number of plants.^{1-3,7} This is based on the assumption that each genome carries one nucleolus-organizing chromosome. A good number of workers have, however, found contrary results.^{4-6,8} While studying the cytology of endosperm in *Zephyranthes ajax*, *Z. grandiflora* and *Nothoscordum fragrans* we made certain observations which have an important bearing on the relationship between nucleolar number and polyploidy level. These are discussed in the present note.

The chromosome number of *Zephyranthes ajax* as determined from the root tips was 2n = 42. Eighty-five per cent. of the endosperm nuclei showed 84 chromosomes. This indicates that the normal cytological constitution of the endosperm in *Zephyranthes ajax* is tetraploid. It may be mentioned that the work regarding the origin of tetraploid nuclei in the endosperm is in progress. Some of the tetraploid nuclei of the endosperm at prometaphase in *Zephyranthes ajax* showed fewer than four nucleoli. The size of these nucleoli in most of the cases was

in no way different from those where four nucleoli per nucleus were present. In a few nuclei where an increase in the size of the nucleoli was noticed, it was not in proportion to the decrease in number. Although the number of nucleoli per nucleus, in general, in the endosperm ranged from one to forty, the range in polyploidy in the tissue was from $4n$ to $16n$ only. The observations in the endosperm were supported by the fact that the maximum number of nucleoli per nucleus was five in the cells of the root which represented the diploid tissue.

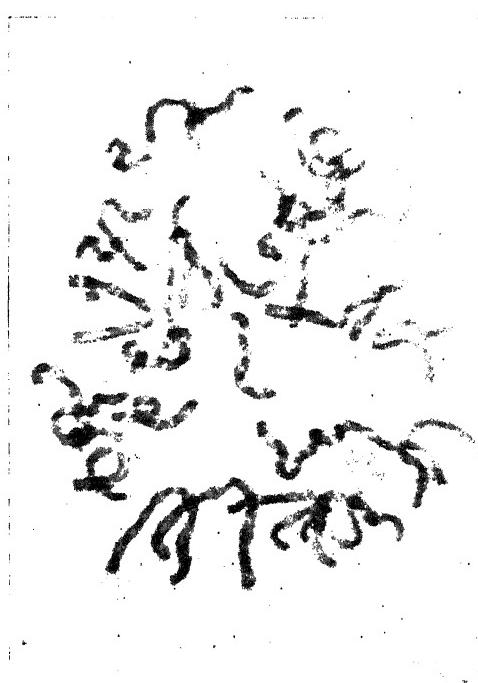


FIG. 1. A triploid nucleus with five nucleoli at prometaphase in *Nothoscordum fragrans*.

The root tips of *Zephyranthes grandiflora* showed $2n = 24$. The majority of endosperm nuclei showed $3n = 36$. Some of the triploid nuclei of the endosperm underwent endo-mitosis as a result of which hexaploid nuclei were formed. The fusion of a hexaploid nucleus with a nucleus showing haploid number contributed to the formation of 7-ploid nucleus. It may be stated that endosperm nuclei with haploid numbers were formed as a result of irregular distribution of chromosomes during anaphase. Whereas the highest polyploidy level in the endosperm of *Zephyranthes grandiflora* was 7-ploid, the maximum number of nucleoli per nucleus was twenty-three. The endosperm of *Nothoscordum fragrans*, in general, also

showed a higher number of nucleoli per nucleus in comparison with its polyploidy level. A good number of triploid nuclei at prometaphase showed five nucleoli per nucleus (Fig. 1). Our findings thus clearly show that the nucleolar number cannot be used as an Index for determining polyploidy level in the endosperm of *Zephyranthes ajax*, *Z. grandiflora* and *Nothoscordum fragrans*.

We are grateful to Professor P. Maheshwari, Head of the Botany Department, University of Delhi, for the facilities and encouragement. The observations reported in this paper are from part of the work which is being done under a research scheme sanctioned by the Council of Scientific and Industrial Research, New Delhi.

Dept. of Botany,
University of Delhi,
Delhi-6, May 2, 1961.

S. L. TANDON.
B. M. KAPOOR.

1. Bhaduri, P. N. and Bose, P. C., *J. Genet.*, 1947, **48**, 237.
2. —, Kar, A. K., *Bull. Bot. Soc. Bengal*, 1948, **2**, 1.
3. Bhatia, G. S., *Ann. Bot. N.S.*, 1938, **2**, 335.
4. Hakansson, A. and Levan, A., *Hereditas*, 1942, **28**, 436.
5. Heitz, E., *Planta*, 1931, **15**, 495.
6. Matsura, H., *Cytologia*, 1938, **9**, 56.
7. Pathak, G. N., *Ann. Bot. N.S.*, 1940, **4**, 227.
8. Sato, D., *Cytologia*, *Fujii Jub.*, 1937, **80**.

PRELIMINARY STUDIES ON PRESOAKING OF CEREALS IN ANTIBIOTICS

At places where wheat and barley are grown in tank beds, the sowings are usually delayed by four to six weeks. Late sowings are also unavoidable in large holdings. Such late-sown crops normally suffer from diseases and insect pests and yields are poor. Presoaking seeds of cereals by various hormones and chemicals have been extensively tested and reported. The use of antibiotic on the rate of pollen tube growth (Sen, 1960) indicated that the growth rate was retarded. Balchandran *et al.* have reported on the control of black arm disease in cotton by spraying antibiotics at three stages of growth. The presoaking of cotton-seed in antibiotics, however, did not give any conclusive results.

A presoaking seed treatment study was undertaken on wheat and barley using Antibiotic (Penicillin G. Sodium). Each vial of antibiotic—200,000, 400,000 and 10,00,000 units was dissolved in 50 ml. of water and the seeds were soaked for 24 hours before sowing. The sowings in the experiment were done on 30th November

1959, i.e., 45 days later than normal sowing, in a randomised replicated trial with the following treatments and a plot size of $6\frac{1}{2} \times 13$ ft.

- | | |
|-------------|--|
| T_1 | Seeds soaked in water, no manuring. |
| T_2 | Dry seeds sown, manuring with 40 lb. N & P per acre. |
| T_3 | Seeds soaked in 2 lac unit solution of antibiotic, no manuring. |
| T_4 | Seeds soaked in 2 lac unit solution, manuring with 40 lb. N & P per acre. |
| T_5 | Seeds soaked in 5 lac unit solution, no manuring. |
| T_6 | Seeds soaked in 5 lac unit solution, manuring with 40 lb. N & P per acre. |
| T_7 | Seeds soaked in 10 lac unit solution, no manuring. |
| T_8 | Seeds soaked in 10 lac unit solution, manuring with 40 lb. N & P per acre. |

Barley.—Barley grain yields also follow, more or less, the same pattern as that of wheat. However, highest concentration soaking has given highest yields. Bhusa yields follow the same trends as that shown with grains.

The results of presoaking seed with antibiotic have shown some interesting trends. It was observed that the crop was disease free and healthy, distinctly more green in colour than their respective controls T_1 and T_2 , and in addition they have given higher yields with marked combination and interaction with manures. Results of importance are noticed as without addition of manures the yields could increase appreciably.

The authors are thankful to Shri Samrath Raj, Director of Agriculture, Rajasthan, Jaipur, for providing necessary facilities.

TABLE I

Average grain and bhusa yields and percentage increase over control in lb. per plot

Treatments	Wheat				Barley				Bhusa yields
	Grain yields	% increase over control	% increase over T_2	Bhusa yields	Grain yields	% increase over control	% increase over T_2	Bhusa yields	
T_1	3.36	..	..	5.63	3.07	..	..	5.51	
T_2	5.14	52.9	..	7.69	4.59	49.5	..	6.86	
T_3	6.81	102.6	32.4	7.18	10.52	242.6	130.5	9.64	
T_4	8.51	153.2	-65.5	8.99	9.28	202.2	102.1	8.94	
T_5	8.96	166.6	-74.3	9.28	10.64	246.5	131.8	9.88	
T_6	8.12	141.6	-57.9	8.56	9.28	202.2	102.1	8.34	
T_7	8.37	149.1	-62.8	8.34	12.36	302.6	169.2	10.78	
T_8	8.12	141.6	-57.9	9.46	11.61	278.2	131.1	11.08	
C.D. at 5%	0.836	..	..	0.703	0.160	..	..	0.384	

Wheat.—Wheat grain yields were significantly affected by the soaking treatments. Antibiotic in lower concentration served the purpose of field manuring. Higher concentrations beyond 500,000 units do not appear to benefit the crop appreciably. Similar significant trends as in grain are visible for bhusa yields.

Department of Agronomy,
Agriculture Department,
Rajasthan,
February 24, 1961.

M. P. BHATNAGAR.
UDAI BHAN SINGH.
G. S. SHEKHAWAT.
B. N. MATHUR.

-
1. Balchandran *et al.*, *Madras Agric. Jour.*, Jan. 1960, 47(1).
 2. Sen, S. K., *Indian Agriculturist*, Jan. 1960, 4(1).

REVIEWS

Lectures on Linear Algebra. By I. M. Gel'fand. Interscience Tracts in Pure and Applied Mathematics. (Interscience Publishers, New York, London), 1961. Pp. ix + 185. Price \$ 6.00.

A good many text-books for post-graduate courses (in the Indian, not the American, acceptation of the term) have been written recently by leading Mathematicians. This is undoubtedly an extremely important and welcome development. It should contribute greatly to improve the quality of Mathematical Education, so often victim of an inordinate attachment to defective traditions and of second-rate books. Academician I. M. Gel'fand needs no introduction and one could easily foresee, before opening his *Lectures on Linear Algebra*, the conclusions which its perusing will confirm. This little book of 185 pages is a masterpiece of clarity and probably the best introduction to the subject which may be recommended at present. The first two chapters deal with the classical notions of finite dimensional spaces, linear and bilinear forms and linear transformations. The subject-matter of the third chapter is less elementary : this chapter is about the theory of canonical matrices, including the main theorems on elementary divisors. Making use of an idea due to I. G. Petrowsky, the author has succeeded in proving these last theorems with an admirable simplicity. No doubt van der Waerden's proofs are also very simple, but they require a good knowledge of Modern Algebra whereas I. M. Gel'fand's proofs are elementary and yet astonishingly short and elegant. The last chapter, about tensors, is only an elementary introduction to this vast field. Only some essential definitions are given. There is no mention of any application. I. M. Gel'fand's lectures should be in the hands of every good post-graduate student.

C. RACINE.

Space Trajectories. Edited by the Technical Staff, Research Division, Radiation Inc. (Academic Press, New York and London), 1960. Pp. x + 298. Price \$ 12.00.

The above volume incorporates the proceedings of a two-day symposium organised by the American Astronautical Society and the Advanced Research Projects Agency, and is

intended to assemble in one publication a comprehensive survey of space trajectory analysis as it existed in 1960. Accordingly it consists of a number of invited papers from applications who summarise the present status of knowledge of space science in its varied aspects, *viz.*, orbit determination, astrodynamics, trajectory computation and re-entry problems.

Satellites and space probes have in the recent past been instrumental to several important discoveries of scientific value. It has been found that the earth is slightly pear-shaped with the stem at the North Pole and that the atmosphere is denser than what it was supposed to be. Satellites have revealed the existence of great radiation belts surrounding the earth and it has been found that there are several zones of trapped charged particles around the earth. The first two chapters of the book give a general survey of the American space programme and its achievements in the technological and scientific fronts.

The mathematical problem of a satellite orbit can be stated as the motion of a particle in the gravitational field of the earth and in the field of a few perturbing forces which are caused by the oblateness of the earth, the atmospheric drag and the gravitational pull of the sun and the moon. Several numerical methods have been devised to calculate the effects of the perturbing forces and these are discussed in the chapter entitled "Astrodynamics". The numerical computation of the trajectories of the satellites calls for the design of complex computers and not less than five chapters of the book are devoted to themes centering round computer design and computer programmes for space missions.

Two other important aspects of space research concern attitude control and the problems of re-entry of a space vehicle into the earth's atmosphere. A scientist should know not only where his satellite is roving about but also the directions toward which his instruments point out. Again the problem of re-entry into the earth's atmosphere poses several difficulties. These questions also have been touched upon by the various authors participating in the symposium.

The book is a valuable addition to the literature on space research.

K. S. V.

Advances in Catalysis and Related Subjects (Vol. XII). Edited by D. D. Eley, P. W. Selwood and P. B. Weisz. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. x + 324. Price \$11.00.

A catalyst, as it was—and perhaps is still—taught in schools, was a substance which accelerated a reaction without participating in it. While one feels that there is something catalytic in the rate at which these volumes are being published, one is also happily assured that the authors are active participants and have made significant contributions in this unique and growing field of research, which is still imperfectly understood in all its details. No doubt deep researches on the nature of crystal structures, the geometrical positions of electrons, ions or atom groups and their energetic conditions, their mobilities within the lattice and at phase boundaries have all helped in a large way to throw much light on the mechanism of catalysis. Still the field is wide and the problems are many and varied.

This volume contains six contributions reviewing recent advances in this field of interest. In the first article on "The wave mechanics of the surface bond in chemisorption", T. B. Grimley, shows how the conventional orbital theory can be applied to the problem of chemisorption on solids.

Nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) provide unique information on the microscopic properties of solids, such as symmetry of atomic sites, covalent character of bonds, strength of exchange reactions, etc. Since the catalytic characteristics of solids are related to the detailed electronic and geometric structure of solids, one can find a correlation between the results of magnetic resonance studies and catalytic properties. D. E. O'Reilly surveys this field in the article on "Magnetic resonance techniques in catalytic research".

The acid-catalyzed conversions of hydrocarbons have been extensively studied, and their applications to petroleum and petrochemical processes are known. On the other hand, the use of bases to catalyze hydrocarbon conversions has received little attention. In the article on "Base-catalyzed reactions of hydrocarbons" H. Pines and L. A. Schaap discuss the use of base catalysis for olefin isomerization, cycloexadiene dehydrogenation, aromatic alkylation, and olefin polymerisation. These reactions are still imperfectly understood. Catalytic mechanisms involving carbanion intermediates have

been used to explain the reactions, and theoretical interest in carbanion chemistry is growing.

R. A. Van Nordstrand has discussed the use of X-ray K-absorption edges in the study of catalytically active solids.

In a detailed article Th. Wolkenstein presents an account of the present state of the electron theory of catalysis on semiconductors. The article includes a summary of the results of work on electronic phenomena in catalysis, carried out mainly in U.S.S.R., in recent years.

The last article is on "Molecular specificity in physical adsorption" by D. J. C. Yates. Although it is generally believed that physical adsorption is essentially non-specific in nature, particularly when non-polar gases are used as adsorbates, Yates shows that specificity is almost as prevalent, although not as obvious, in physical adsorption as in chemisorption. The application of infra-red spectroscopy to the problem has enabled significant results to be drawn on the changes a molecule undergoes on adsorption. Thus the appearance of new bands in the spectra of adsorbed molecules, at frequencies which correspond to Raman frequencies shows directly the existence of induced dipoles in them.

A. S. G.

Error Correcting Codes. By W. W. Peterson. (The MIT Press and John Wiley and Sons, Inc., New York), 1961. Pp. x + 282. Price \$ 7.75.

The author of this book has been associated with the IBM and the MIT, and has justified this association in the writing of this book. It is, to some extent, novel in its title, the subject-matter, and the manner of presentation.

The book is restricted in scope in the sense that it deals exclusively with error-detecting and error-correcting codes for information, transmission and storage systems. The first five chapters are concerned with the well-known coding theory and systems. The last seven chapters are devoted to developments during the last three or four years. During this period, there has been, in one sense, a considerable volume of contributions, but, in another, really very little! Under the circumstances, sifting material and presenting it is a difficult task which the author has tried to accomplish reasonably well. Of the five appendices in the books two provide valuable information, viz., one giving a table for the entropy function and the other giving a table of irreducible polynomials over GF (2). There is also a novel appendix which lists the sections of the book that must be read before deciding to read a particular chosen

fection in the book. The first ten chapters can be considered as a course on information theory.

The book should be useful to information theorists, data transmission engineers and computer engineers. The author has avoided using concept of homomorphism and isomorphism, but considers the properties of finite fields important, and so on. There are, undoubtedly, matters of opinion. However, they do not reduce the value of the book which has certainly a place as a contribution of current interest.

The printing and get-up of the book is good and the diagrams are neatly drawn.

S. V. C.

Perspectives in Virology, Vol. II. Edited by Morris Pollard (Published for the Gustav Stern Foundation of New York, Burgess Publishing Co., Minneapolis). Pp. x + 220. Price \$ 8.00

The publication represents the proceedings of a symposium held in New York during January 1960 sponsored by Gustav Stern Foundation in honour of Dr. Peyton Rous. He was honoured by the participants of the symposium on the fiftieth anniversary of his report on the Rous Sarcoma and his eightieth birthday.

The information contained in this book ranges from fundamentals of Virology to Applied Biology in its 45 chapters described in about 200 pages. The subject-matter is varied. To mention a few: Studies on Polio Virus; origin, time of synthesis; Studies on Kappa particles; Structure and composition of viruses; Nature and function of 'Interferon' and potentialities of further research.

Anyone who had the opportunity of participating in the symposium would appreciate the true description of the articles presented and the discussion that followed. The remarkable growth of knowledge in Virology in recent times is strikingly seen by every reader. This amply justifies the necessity of conducting similar symposia more frequently in different countries.

The author Dr. Morris Pollard is not only a veteran virologist but also a professor of Preventive Medicine in a leading University in U.S.A. He creditably shouldered the responsibility of organising and conducting the above Symposium in which more than a hundred eminent Virologists from several countries participated.

The several exciting new developments in Virology is bound to attract and stimulate the interests of both Plant and Animal Virologists. The book is sure to serve as a useful 'Reference

Book' in every Virus and Biochemical Laboratory engaged in fundamental research work.

D. P. NARASIMHA MURTHY.

Carcinogenesis. By I. Hieger. (Academic Press. New York and London; India: Asia Publishing House, Bombay-1), 1961. Pp. 138. Price 35 sh.

It is true that our understanding of the cancer problem is inversely proportional to the number of theories put forth to explain it. The fact that there are a number of theories on carcinogenesis speaks volumes about the inadequacies of our knowledge of the disease and the processes that lead to it. An authoritative book to take stock of the various theories and to weed out the untenable has been wanting for a long time. The book on "Carcinogenesis" by I. Hieger tries to cover up the possible avenues of experimental carcinogenesis. The author has taken pains over stating his own critical views about the present state of our knowledge on carcinogenesis. He further has submitted the work of Darlington, Green, Burnet, Coulson, Badger, Haddow, Huxley, Lederberg and Muller (Chapters 1 to 4) to sharp criticism. The author is fully aware of the lengthy quotations from the reviews and references which have been profusely used.

Chapters 5 and 6 on "Carcinogenesis as a multistep process" and the work of Earle, Warburg and Cowdry are well written.

A few printing errors have occurred on pages 33 and 81.

On the whole the book on "Carcinogenesis" appears to be a critical commentary and gives a fair account of the present position of our knowledge on the processes of carcinogenesis. It would, therefore, be of more value to a person who is intended and well versed in cancer research.

V. R. KHANOLKAR.

Illustrated Genera of Wood Decay Fungi. By Charles L. Ferguson. (Burgess Publishing Company; Minneapolis, Minnesota), 1960. Pp. i-iv + 132. Price \$ 4.00.

The appearance of this manual reflects the current interest in fungi which cause decay in wood. The difficulty of proper identification of these fungi is known to all those who are interested in this group and admittedly the main purport of a manual on this group should be to solve this difficulty. In the words of its author, the book is intended to provide a means for the identification of wood decay fungi and to help particularly those not trained in mycology and

who lack the taxonomic experience and information of the sources of relevant taxonomic literature.

There is a short introduction on the use of the Keys and directions for the collection of the fungi, followed by a Key to the Families, a supplementary Key to the common genera, Keys to the genera of the Families, a list of general references, a glossary and an index to the genera. Eighty-one genera, all belonging to the Basidiomycetes, are included. While it is true that the majority of the fungi causing decay in wood belong to this group, the omission of some of the Ascomycetes such as species of *Ustulina* and *Xylaria* and of several operculate and inoperculate Discomycetes lends a halo of incompleteness to the work. Indeed, these could well have been included in place of such genera as *Exobasidium*, *Septobasidium*, *Tremelodendron*, *Clavariadelphus*, *Ciavulina*, etc., which either cause no decay at all in wood or are not important from this angle. Species of *Exobasidium*, for example, cause galls mainly on leaves. *Septobasidium* spp. occur in association with scale insects. The inclusion of both these genera in this manual is misleading. On the other hand, *Ganoderma* Karst. (Polyporaceæ) is not mentioned, although species of this genus commonly attack wood.

Several important taxonomic papers on wood decay fungi are listed under "General References", but this list could have been more exhaustive. It is surprising that the nomenclature of the fungi mentioned has not been brought in line with recent revisions, many of which are quoted but not followed. For instance, *Tremelodon* (Pers.) Fr. (p. 24) is used in place of *Pseudohydnum* Karst., and *Guepinia* Fr. (p. 32) in place of *Dacryopinax* Martin. The author citations for the genera will have to be carefully checked from the references given or from other monographs. The author citations for the species mentioned are not given. A manual like this should not only provide accurate and clear descriptions of the various fungi but should also be sound and reliable in regard to the nomenclature of the fungi. In regard to the latter, the text falls short of the requirements. The Keys form an important part of the text, but it is not clear how *Aleurodiscus oakesii* is keyed out under *Stereum* (p. 50). On page 69 we find that species of different genera are keyed out together and the following statement is appended: "All of these important tooth fungi are designated as species in pathology text-books such as Baxter and Boyce"! Again, on page 81 species of different genera are presented in the

same Key under the genus *Irpex* and then it is stated that "species that are most often confused with *Irpex* have been included in the Key for ease of identification".

The book is admirably illustrated with good photographs. The materials for a revision of this work will be found in the literature quoted under General References and it is hoped that the author will soon provide us with a revised text which will be more reliable. Until then the book will be found useful by those who are trained in mycology and who know at least some of the basic principles and pitfalls in the nomenclature of fungi.

C. V. SUBRAMANIAN.

Beautiful Climbers of India. By B. P. Pal. (Indian Council of Agricultural Research, New Delhi), 1960. Pp. 105. Price Rs. 8.

This superbly illustrated little book is another very commendable publication in the authoritative series on horticulture and ornamental gardening being published by the I.C.A.R., New Delhi.

We do not have much horticultural literature adapted to indigenous needs—not even good nursery catalogues which can compare with their glossy, profusely illustrated counterparts abroad giving plenty of useful information, albeit with a commercial slant. Nor do we have in this country any class of gardening experts as such, similar to the experienced nursery-men and knowledgeable head-gardeners of the west. We have, instead, a minority highly qualified in botany, agriculture, or allied science who come to gardening via their subject, or at the other extreme, the near-illiterate *malis* with some individually garnered practical knowledge. Aspiring amateur gardeners, such as those building houses and/or laying out new gardens, have either to go by rule of thumb or burden themselves with scientific data. In such a context a book like the one under review is of considerable utility. Here is contained accurate information based on personal experience and written in a language easily intelligible to the layman.

Following a brief Introduction, Chapter I gives practical hints on growing the various types of light and heavy climbers, and positions suited to particular ones. Chapter II gives further information on the same lines and is helpful in making a choice. Chapter III deals in detail with about 30 select climbers and is interspersed with excellent illustrations in full colour. The climbers are described as to habit, floral and other peculiarities, and manner of growth and propagation.

Nearly all of the climbers described are extraordinarily lovely yet common enough to be readily obtainable. No one can look unmoved on the glorious *wistaria*, *pyrostegia*, *banisteria*, *petrea*, *Mina lobata*, *elerodendron* (particularly *C. splendens*), or the *bougainvillea* Mary Palmer. Even the universally met with *antigonon*, *jacquemontia*, rambler roses, *allamanda* or common *bougainvilleas* have their own appeal. They have their place and always will, whatever the dizzy heights of hybridization, yet to be reached.

A minor point regarding the book may be mentioned: While indicating the size of flowers, it could have been given in approximate number of inches as the terms large and small are variously interpretative, and the close-up pictures of certain blooms—e.g., *Allamanda banisteria*, *Beaumontia grandiflora*—may be quite misleading to one who has not seen them in growth.

Among scented flowered creepers the Indian cowslip (*Pergularia odoratissima*) and the creeping tuberose (*Stephanotis floribunda*) could with advantage have been included without noticeable enlargement of the book. But as Dr. Pal points out a selective list has to be perfectly arbitrary.

A very useful table is appended containing botanical and common names and characteristics of the climbers; together with the season of flowering. The index at the end is useful for referring to species and varieties. *Beautiful Climbers of India* is a book that should find a place in all school and college botany libraries as well as prove of general popular appeal.

I. H.

General Physical Science. By G. G. Mallinson, J. B. Mallinson and R. F. Welch. (McGraw-Hill Book Co., New York), 1961. Pp. xii + 628.

This is a book of General Knowledge in science and presents in a most interesting manner the basic principles of the physical sciences and their applications in chemistry, physics, geology, astronomy and meteorology. The developments that have taken place in the last decade or two in physics have made general physical science a highly popular course in high schools. Although the book is essentially written for the benefit of the high school students, grown-ups can supplement their knowledge by the up-to-date information provided here in various areas of popular science. The book will be particularly of use to students in India who take competitive examinations which

include a paper on General Knowledge (Science). The illustrations are both instructive and attractive. The get-up is excellent.

A. S. G.

Basic Principles of Fission Reactors. By W. R. Harper. (Interscience Publishers, New York), 1961. Pp. viii + 314. Price \$ 7.50.

Time is not far off when the essentials of Reactor Physics and Technology will have to be included as part of the regular course to post-graduate students in science and engineering in Universities in India, as it is being done in those of the scientifically more advanced countries. Even now there are a small number of institutions in the country which cater to this and there are quite a few students of science and engineering who are interested in the subject. To them this book on the "Basic Principles of Fission Reactors" can be recommended as an introduction to the subject. The treatment is such as will take the reader with the ordinary background knowledge of physics and mathematics to about the stage at which detailed reactor design begins. The reactor itself forms the main subject of the book, but ancillary topics such as radiation protection, health physics, waste disposals, etc., have also been briefly referred to.

Physical Chemistry (2nd Revised Edition). By E. A. Moelwyn-Hughes. (Pergamon Press, London, W. 1), 1961. Pp. vii + 1,333. Price 84 sh.

This outstanding text-book on Physical Chemistry written by an experienced teacher of the subject needs no introduction or elaborate reviewing. It became immediately popular as soon as it was first published in 1957. It is not surprising that there has arisen a demand for its reissue. In the second edition the author has taken care to revise the text in the light of more recent advances and bring the book up-to-date.

Analytical Elements of Mechanics, Vol. 2—Dynamics. By T. R. Kane. (Academic Press, New York and London; India: Asia Publishing House, Bombay-1), 1961. Pp. xvi + 337. Price \$ 6.25.

This is the second of the twin volumes on "Analytical Elements of Mechanics" by Prof. T. R. Kane, intended for use in Engineering courses. The first volume deals with Statistics and the present volume is concerned with Dynamics. As before the symbolic language used is vector analysis.

According to the author the greatest obstacles standing in the way of effective solution of problems in particle and rigid body dynamics are inadequate understanding of kinematics and theory of moments and products of inertia of rigid bodies. Accordingly the author has devoted much attention to these topics and the treatment also is from a new approach.

More than a hundred illustrative problems are worked out in the text. Like its companion volume on Statics the present volume will be of value to students of engineering and technology.

Proceedings of the Natural Rubber Research Conference 1960. (The Rubber Research Institute of Malaya, P.O. Box 150, Kuala Lumpur, Selangor, Federation of Malaya), 1961. Pp. xix + 986. Price \$ 23 (Malaya), \$ 7.50 (U.S.) or £ 2-13-8 (postage extra).

International Conferences on natural rubber research have been few and far between. Since the end of World War II there have been only two Conferences of this kind, one in Malaya in 1950, and the other at Bogor in 1952. The 1960 Conference held in September 26–October 1, in Malaya, however, surpassed the previous two, both in the number of participants and in the range of subject covered.

About 300 participants from twenty different countries from all the five continents attended the Conference, and they included not only research workers but also those concerned with the growing of rubber, the manufacture, and the organisation of the industry.

With the advent of synthetic rubbers the almost unchallenged position that natural rubber held for over fifty years has changed, and there is need to intensify research work on natural rubber in all its different phases of growth, manufacture, processing and marketing. This voluminous report of the *Proceedings of the Natural Rubber Research Conference* bears testimony to the progress that is being made in these directions.

The 1,000-page report is in three parts. Part I contains the proceedings of the General Sessions which includes amongst others the addresses of Professor James Bonner on *The Biogenesis of Rubber*, of Prof. G. E. Blackman on *The Stimulation of Latex Flow by Plant Growth Regulators*, and of Prof. G. Gee on *New Methods of Elastomer Synthesis and their Impact on Natural Rubber*. Part II contains 34 papers covering various aspects of Natural Rubber Production, and Part III 42 papers on Preparation and use

of latex, its chemistry and technology, its biochemistry and microbiology.

The volume containing as it does the latest information and results of research on the subject should be in the possession of all organisations which have anything to do with natural rubber and natural rubber research.

Books Received

Spectroscopy (Vol. 1). *Atomic, Microwave and Radio-frequency Spectroscopy*. By S. Walker, and H. Straw. (Chapman and Hall, London, W.C. 2), 1961. Pp. xix + 267. Price 50 sh.

Scotland's Scientific Heritage. By A. G. Clement and R. H. S. Robertson. (Oliver and Boyd Ltd., London, W. 1), 1961. Pp. 151. Price 18 sh.

Scientific Research in British Universities 1960-61. (Department of Scientific and Industrial Research, Charles House, London, S.W. 1), 1961. Pp. xiii + 513. Price 12 sh. 6 d.

The Rare Earths. By F. H. Spedding and A. H. Daane. (John Wiley and Sons Inc., New York-16; India: Asia Publishing House, Bombay-1), 1961. Pp. xi + 641. Price \$ 14.75.

From: Academic Press, 111, Fifth Avenue, New York-3; India: Asia Publishing House, Bombay-1:

International Review of Cytology (Vol. 11). Edited by G. H. Bourne and J. F. Danielli, 1961. Pp. xii + 356. Price \$ 11.00.

The Optimal Design of Chemical Reactors. By Rutherford Aris, 1961. Pp. xi + 191. Price \$ 7.00.

Mechanisms in Radiobiology—General Principles. Edited by Maurice Errera and Arne Forssberg, 1961. Pp. xv + 534. Price \$ 16.00.

Interfacial Phenomena. By J. T. Davies and E. K. Rideal, 1961. Pp. xiii + 474. Price \$ 14.00.

Fish as Food (Vol. 1). *Production, Biochemistry and Microbiology*. Edited by G. Borgstrom, 1961. Pp. xv + 725. Price \$ 24.00.

Physical Chemistry (Vol. 9). *Photochemistry of Air Pollution*. By Philip A. Leighton, 1961. Pp. ix + 300. Price \$ 11.00.

The Cell (Vol. 11). *Biochemistry, Physiology, Morphology*. Edited by J. Brachet and A. E. Mirsky, 1961. Pp. xiv + 916. Price \$ 25.00.

Advances in Agronomy (Vol. 13). Edited by A. G. Norman, 1961. Pp. xi + 386. Price \$ 12.00.

Advances in Applied Mechanics (Vol. 6). Edited by H. L. Dryden, Th. von Karman and G. Kuerti, 1961. Pp. x + 294. Price \$ 9.00.

Protein Structure. By Harold A. Scheraga, 1961. Pp. xi + 305. Price \$ 8.00.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Miss V. Sarojini for her thesis entitled "Experimental Investigations on the Dielectric Behaviour of Certain Liquid Mixtures"; D.Sc. Degree in Chemistry to Messrs. Ch. Bheemasaṅkara Rao and N. Venkateswara Rao for their theses entitled "A Study and Synthesis of the Chemical Constituents of Some Indian Medicinal Plants and Related Compounds" and "Oxidometric Methods for the Determination of Dyes and Studies on the use of Phthalocyanines as Oxidation-Reduction Indicators" respectively; D.Sc. Degree in Pathology to Sri. S. S. Sriramacharyulu for his thesis entitled "Studies on the Pathogenesis of Dietary and Toxic Cirrhosis of the Liver"; D.Sc. Degree in Geology to Sri. M. Satyanarayana Murty for his thesis entitled "Structure, Mineralogy and Petrology of Charnockite Series and Associated Rocks of the Visakhapatnam Area".

Utkal University has awarded the Ph.D. Degree in Chemistry to Shri Bhaskar Das for his thesis entitled "Thiazole Derivatives".

Bombay University has awarded the Ph.D. Degree in Physics to Shri M. G. Joshi of Tata Institute of Fundamental Research for his thesis entitled "Measurement of Internal Conversion Coefficients and Energy Levels of Some Nuclei"; Ph.D. Degree in Cytology to Shri N. V. Aswathanarayana for his thesis entitled "The Vacuole and the Nucleus of *Saccharomyces cerevisiae* and *Saccharomyces bayanaus*".

The Raptakos Medical Research Board Fellowships

The Raptakos Medical Research Board Fellowships for the year 1962 have been awarded to the following candidates: Dr. Prasanta Basu, Institute of Post-graduate Medical Education and Research, Calcutta; Dr. Naunihal Singh, All-India Institute of Medical Sciences, New Delhi; Dr. Tarakdas Banerjee, Nilratan Sircar Medical College, Calcutta; Mr. Ram Prakash Agarwal, K.G. Medical College and Lucknow University, Lucknow; Miss Vijayalaxmi Ramachandra Menon, J.J. Group of Hospitals, Bombay.

Symposium on Scombroid Fishes

The Marine Biological Association of India announces the holding of the Symposium on

"Scombroid Fishes" from 12 to 15 January 1962 at Mandapam Camp. Of the 74 articles contributed to the Symposium, more than half the number come from 14 countries of the world outside India.

The Symposium is open to all members. However, non-members wishing to attend the Symposium may do so on payment of a "Symposium Fee" of Rs. 25. They will be entitled to receive the published proceedings of the Symposium at a concessional rate.

In view of the limited accommodation facilities available at Mandapam Camp, members desirous of attending the Symposium are requested to inform the Secretary, Marine Biological Association of India, Mandapam Camp, before 31 December 1961.

Two New Journals—*Experimental and Molecular Pathology* and *The Journal of Catalysis*

Academic Press, Publishers, New York and London, have announced the publication of the following two new journals in 1962: *Experimental and Molecular Pathology*, a new international journal, devoted to original papers on the application of traditional methods, as well as the newer techniques of analytical chemistry, histochemistry, pharmacology, toxicology, and electron microscopy, to problems of human and animal pathology. Dr. Frederick Coulston and Dr. Wilbur A. Thomas will be the editors of the new journal. Papers on virology, endocrinology, immunology, nutrition, chemotherapy, and geographic pathology, studies on the mechanism of action of drugs, vaccines, pyrogens, and other substances, when related to alterations in tissues, will be accepted. All articles will be in English. Volume I, consisting of six issues, will be released in 1962, at \$ 18.00.

The *Journal of Catalysis* which will be a medium of publication for all original scientific studies in heterogeneous catalysis, as well as subjects related to homogeneous catalysis. Studies relating to catalytic properties with chemical processes at surfaces, including the study surfaces by various physical means, will be included in the scope of this Journal, as will molecular rate processes and studies of the chemistry of surfaces. Professors J. H. de Boer and P. W. Selwood have agreed to become editors of the new periodical.

Volume I, Number 1 is scheduled for release early in 1962.

Subscription orders should be sent to the publishers, Academic Press, Inc., 111, Fifth Avenue, New York-3, New York.

Tolyposporium ehrenbergii (Kuhn.) Pat.

Dr. Mir Hamid Ali of the Department of Entomology and Plant Pathology, College of Agriculture, Osmania University, writes to say that *Tolyposporium ehrenbergii* (Kuhn.) Pat., the long smut of Sorghum has been recorded from the Mahboobnagar District (of the erstwhile Hyderabad State) for the first time. The measurements of this fungus agree with those reported by Kulkarni.

Sound Waves Trapped in the Solar Atmosphere

It has been suggested that the presence of a field of pressure waves may play a role in determining the fine structure and temperature of the solar atmosphere. According to the mechanism, first proposed by Lighthill, sound waves could be generated in a turbulent fluid. In the solar atmosphere the region of turbulence is identified with the convective layer in and just below the photosphere. Further the solar atmosphere has a distribution of temperature with a pronounced minimum of optical path $\tau = 0.01$. Sound waves with a wide variety of initial directions, will therefore be prevented by refractive effects from leaving the region. At the level where the temperature is smallest, the local speed of sound waves increases in both directions away from this level. The waves will follow a sinusoidal path about this level with a spatial period.

F. D. Kahn (*Astrophys. J.*, 1961, 134, 343) has shown that the effect of these trapped sound waves is to produce a pattern which will tend to repeat itself at intervals of about 5 minutes, with distortions of about 2,250 km. This may lead to a 5-minute periodicity in the appearance of the fine structure of the sun. It is interesting to note that Leighton recently found that, viewed in certain spectral lines, the pattern of Doppler shifts in the Sun seemed to repeat itself after about 297 seconds. The agreement between Leighton's observations and Kahn's deductions suggests that there may be a connection between the two.

Hydrogen Cloud of Terrestrial Origin

Since the recent discovery of the diffuse Ly- α radiation in the night sky, it has been generally thought that this radiation was of interplanetary origin. It now seems that this hypothesis must be discarded because plausible models of the

interplanetary medium contain much less neutral hydrogen than is required to explain the observations. An alternate hypothesis concerning the origin of the diffuse Ly- α radiation is that it may originate in a hydrogen cloud associated with the earth. A model was proposed according to which most of the scattering takes place in the geocentric distance $2.5-5 R_E$ (earth radius).

In a paper (*Astrophys. J.*, 1961, 134, 395) John C. Brandt presents evidence which indicates that the night-time Ly- α observations can be attributed to solar radiation scattered by a cloud of hydrogen of terrestrial origin located at geocentric distances greater than about 5-10 earth radii. It also appears that the earth has a comet-like tail of hydrogen in the antisolar direction. According to Brandt, hydrogen distribution can be idealized as being composed of two parts: a spherical distribution about the earth of 10 neutral hydrogen atoms per c.c. and of characteristic radius $10^2 R_E$. This distribution can be called the "geo-coma" and is mainly responsible for the Ly- α radiation; the second part is the "geo-tail"—a tenuous downward extension in the antisolar direction of characteristic length $10^3 R_E$, width $10^2 R_E$ and mean density $10^{-1}/\text{cm.}^3$.

Radioactive Wastes Fixed in Glass

With the expansion of the atomic energy industry, much attention is being devoted all over the world to the development of effective, safe and inexpensive methods for the disposal of radioactive wastes. Laboratory work over the last few years at the Chemical Engineering Division of the U.K. Atomic Energy Authority at Harwell, has shown that it may be possible to store the highly radioactive wastes by converting them into insoluble glass-like solids. Design of a pilot plant to handle 1,000 curies of active waste per batch has now reached an advanced stage.

The glass is produced by making a slurry of silica and borax in a nitric acid solution of the concentrated liquid wastes, which, when evaporated to red heat, sinters and melts, and on cooling solidifies to a glass of chosen composition. A typical product might contain from 20-30% by weight, of waste oxides.

Experimental work has shown that the properties of the glass remain substantially unchanged when samples are subjected to a radiation dose of 10^{11} rads. This dose is comparable with the dose received by a glass incorporating high activity waste which has been stored for 500 years.—(Atom).

Micrometeorite Layer at High Altitudes Around the Earth

The Air Force Cambridge Research Laboratories, Bedford, Mass., have announced the discovery of what appears to be a dense band of micrometeorites which envelopes the earth at extreme altitudes. This discovery was made recently when the contents of a novel rocket nosecone specially designed for trapping micrometeorites were examined. The nosecone was launched on June 6, 1961 at White Sands, New Mexico. The density of the micrometeorites in this layer was totally unexpected. About 10 of these small particles struck each square centimetre of the detecting surfaces each second. The dust particles measured in microns apparently exist as a band about the earth that is independent of latitude or longitude.

The special nosecone for trapping and recovering these micrometeorites consisted of a pod-like arrangement made up of individual petals or leaves. At an altitude of 47 miles these leaves opened like a blossoming flower. The nosecone was carried to a maximum altitude of 102 miles; the leaves closed again when the rocket descended to 65 miles. Altogether the nosecone remained open for about 4 minutes.

The micrometeorite detectors used consisted of a triple layer of physically separated Mylar and Plexiglas sheets each about $2'' \times 3''$. The top layer consisted of a mylar film $\frac{1}{4}$ mil. ($1/4,000$ ths in.) thick; second layer, also of mylar was 1 mil. and the bottom layer was a $\frac{1}{8}$ " thick sheet of plexiglas. Detectors of this type were located on each of the leaves of the nosecone. The micrometeorites travelling at speeds up to 47 miles a second, passed through the two mylar film layers, creating many holes, most of which were microscopic in size. When they struck the harder plexiglas layer below, small craters readily visible were created.—(J. Frank. Inst., 1961, 272, 248.)

Low Temperature Transformer

A new kind of transformer that may become a major innovation in power technology was described by its inventor Dr. McFee at a meeting of the American Institute of Electrical Engineers in Ithaca, New York. The new transfor-

mer has been successfully operated at a level of 15 kilowatts. Transformers using the new design could be considerably lighter and less costly than conventional transformers. And they would not be subject to the substantial power losses caused by electrical heating, or to the temperature limitations of present-day electrical insulation.

The new design makes use of superconductivity—the ability of certain metals to conduct an electric current without any resistance at temperatures near absolute zero. Superconducting transformers have been considered before, but the fact that a moderately strong magnetic field can quench the superconducting state by restoring electrical resistance presented an apparently insurmountable obstacle. When an electric current flows through a coil, such as the windings of a transformer, powerful magnetic fields are generated about the windings and quench the superconductivity when they reach a critical field strength.

Dr. McFee discovered that interleaving layers of the primary and secondary windings would keep the total magnetic field below the critical level. Since the current in adjacent layers flows in opposite directions, the magnetic fields generated about these layers are also opposing. In effect, the individual magnetic fields nearly cancel one another and eliminate the problem of magnetic quenching.

The Gifford-McMahon helium refrigerator invented at A.D. Little Inc., provided a solution to another major problem in the development of a practical superconducting transformer. There had not been a simple, reliable method of maintaining the superconducting coils at the necessary low temperatures for an extended period. Now in its final stages of development, the new refrigerator will produce temperatures to -452°F . and will maintain them unattended for months of continuous operation.

Since the cost of refrigerating the whole transformer would be excessive, only the superconducting coils themselves are cooled, while the cores are kept at room temperature. Heat leaks into the system are controlled by vacuum insulation, liquid-nitrogen heat shields, and an ingenious arrangement of the superconducting input leads.—(J. Frank. Inst., 1961, 272, 245.)

913-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, Current Science, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00 ; £ 1-4-0 ; \$ 4.00.